Bayou Chauvin
120507
Watershed Implementation Plan

Swamp east of Bayou Chauvin in Subsegment 120507

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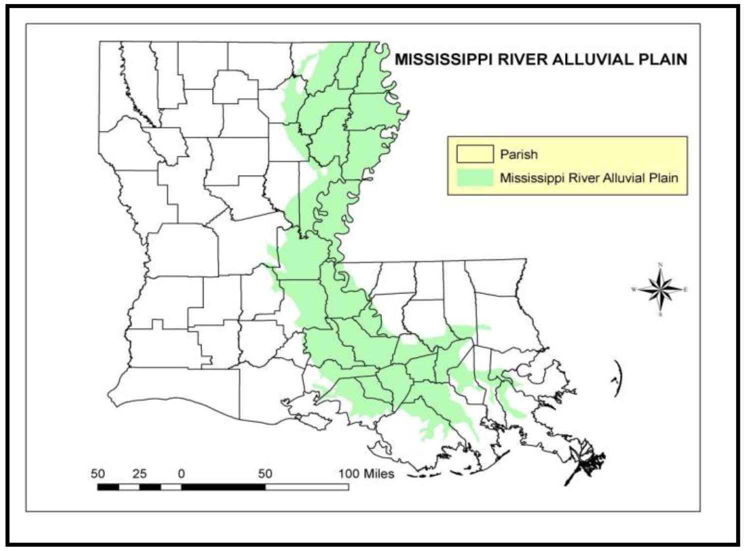
1.0 INTRODUCTION

Section 303(d) of the 1972 Clean Water Act (CWA) requires all states to develop a list of their state's impaired waterbodies. The 303(d) list of impaired waterbodies consists of those waterbodies that do not meet state regulatory water quality standards even with the current pollution controls in place and after point sources of pollution have installed the minimum levels of pollution controls and are in compliance with current permit processes and point source effluent limitations as outlined in Title 33 Environmental Quality Environmental Regulatory Code, Part IX, Water Quality (LDEQ, 2002).

Bayou Chauvin, subsegment 120507, of the Terrebonne Basin is listed on the 1999, 2002, and 2004 CWA's Section 303(d) list. The subsegment is listed as not supporting any of its designated uses which are Primary Contact Recreation, Secondary Contact Recreation, and Fish and Wildlife propagation. In the draft 2006 303(d) list, the water is fully supporting Primary and Secondary Contact Recreation and is not supporting Fish and Wildlife Propagation. The suspected causes of impairment are low dissolved oxygen and nutrients. The suspected sources are municipal point source discharges, small flow discharges, sanitary sewer overflows, and total retention domestic sewage lagoons. Therefore, the Louisiana Department of Environmental Quality (LDEQ) and the United States Environmental Protection Agency (USEPA) have developed Total Maximum Daily Loads (TMDLs) for these pollutants. The CWA requires that states develop TMDLs for the waterbodies listed on the 303(d) list. TMDLs provide reduction goals for point and nonpoint source loading into the waterbody. LDEQ is developing implementation plans for the waterbodies/watersheds for which TMDLs have been developed.

Bayou Chauvin conveys intermittent flow from the Houma stormwater pumps located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. It is believed that stormwater conveyed by the bayou is primarily responsible for violations of dissolved oxygen criteria. No permitted dischargers are located in this subsegment. There is significant oil and gas activity, but these facilities are no longer allowed to discharge into waters of the state. Additionally, the Houma South Wastewater Treatment Plant, though located in this subsegment, discharges to the Houma Navigation Canal and does not impact Bayou Chauvin. Because of the impairment, this subsegment requires the development of a total maximum daily load (TMDL) for oxygen demand substances and nutrients. A calibrated water quality model for the Bayou Chauvin, subsegment 120507 watershed was developed and projections for current dissolved oxygen standards were run to quantify the wasteload required to meet established dissolved oxygen criteria.

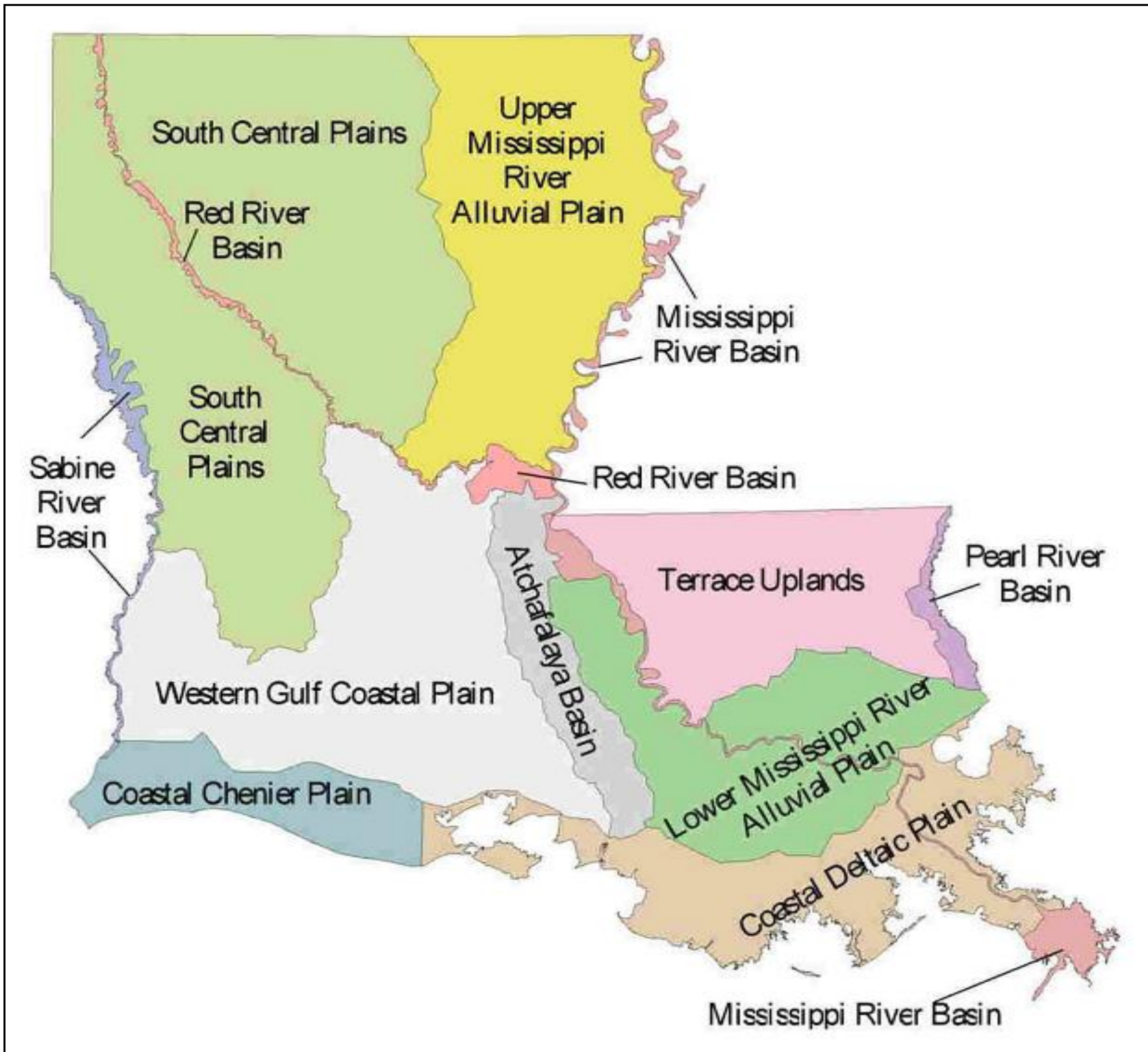
1.1 Ecoregion Description: Mississippi River Alluvial Plain



Map of Mississippi River Alluvial Plain

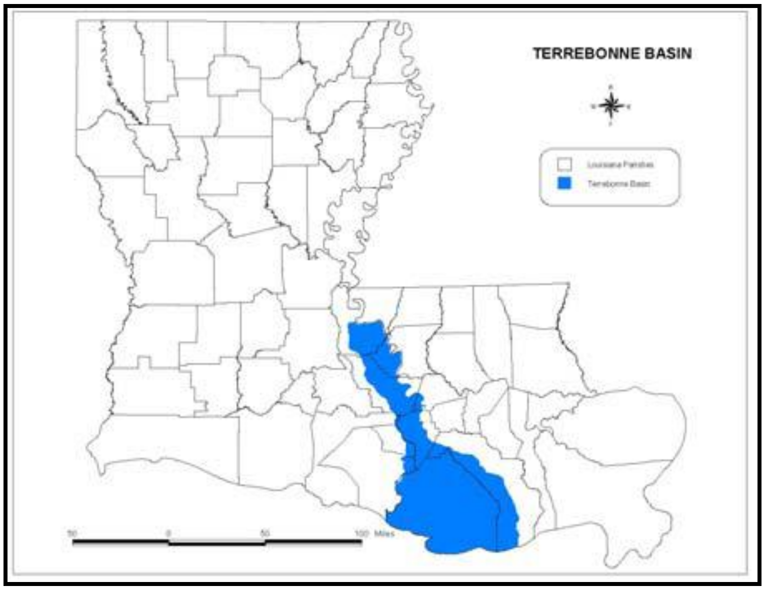
The Mississippi River Alluvial Plain (MRAP) ecoregion extends from the very southern tip of Illinois down through southeastern Missouri, encompasses all of eastern Arkansas, the delta region of Mississippi and into northeast Louisiana then south following the Mississippi River to where its bottomland forests meet the coastal marshes. The ecoregion includes all or portions of East Carroll, West Carroll, Morehouse, Ouachita, Richland, Madison, Franklin, Caldwell, Tensas, Catahoula, LaSalle, Concordia, Avoyelles, Rapides, Evangeline, St. Landry, Pointe Coupee, West Feliciana, West Baton Rouge, East Baton Rouge, Iberville, St. Martin, Lafayette, Iberia, St. Mary, Assumption, Terrebonne, Lafourche, St. James, Ascension, St. John the Baptist, Livingston, Tangipahoa, St. Charles, Jefferson, Orleans, Plaquemines, and St. Bernard Parishes. The MRAP, is rich in alluvial sediments, and is known primarily for its Bottomland Hardwood Forest, its natural community types, and its Cypress and Cypress-Tupelo Swamps. In addition, the northeastern portion of this eco-region contains both Wet and Mesic Hardwood Flatwoods which are found on Macon Ridge. Federal lands include Indian Bayou WMA (COE), Black Bayou Lake, Handy Break, Tensas River, Bayou Cocodrie, Catahoula Lake, Lake Ophelia, Grand Cote, Cat Island, Atchafalaya, and Bayou Teche NWRs. Wildlife Management Areas include Bayou Macon, Big Colewa Bayou, Floy McElroy, Russell Sage, Ouachita, Big Lake, Buckhorn, Mississippi River Alluvial Plain Ecoregion. Boeuf, Dewey W. Wills, Red River, Three Rivers, Grassy Lake, Spring Bayou, Pomme De Terre, Thistlethwaite, Sherburne, Joyce, Manchac, Maurepas Swamp, Attakapas Island, and Elm Hall. State parks include Chemin A Haut, Lake Bruin, Lake Fausse Point, and Cypremort Point. State historic sites include Poverty Point, Winter Quarters, Marksville, and Longfellow-Evangeline.

Map of Louisiana Ecoregions



1.2 Terrebonne River Basin Description

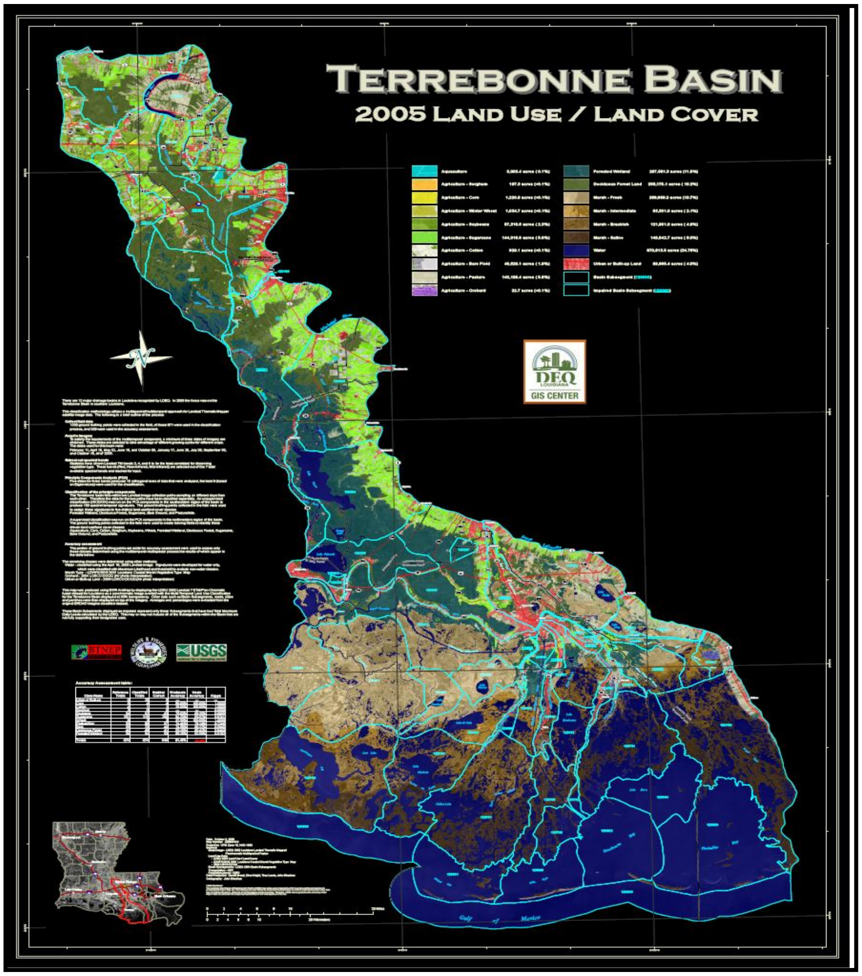
The Terrebonne Basin covers approximately 1,712,500 acres in south-central Louisiana, and is bordered by Bayou Lafourche to the east, the Atchafalaya Basin floodway to the west, the Mississippi River to the north, and the Gulf of Mexico to the south. It varies in width from 18 miles to 70 miles. It includes all of Terrebonne Parish and parts of Lafourche, Assumption, St. Martin, St. Mary, Iberville, and Ascension Parishes. The topography of the entire basin is lowland, and all the land is subject to flooding except the natural levees along major waterways (LDEQ, 1994). The extreme northern portion of the basin is primarily agriculture lands which continue south along its eastern edge within the historic floodplains of the Mississippi River and Bayou Lafourche. The western half of the basin consists of bottomland hardwood forests and cypress-tupelo-



Map of the Terrebonne Basin

black gum swamps. The coastal portion of the basin is prone to tidal flooding and is comprised of fresh and intermediate marsh inland to brackish and salt marsh near the bays and gulf. Approximately 729,000 acres of the Terrebonne Basin are wetlands which consist of about 21% freshwater swamp and 79% marsh. The two primary water sources that enter this system are rain water and flood water from the Atchafalaya River, which contain nutrient-rich sediments that overwhelm the southwestern coastal marshes. There are roughly 57 species of freshwater fish, 12 species of mussels, and 10 species of crawfish found within the Terrebonne Basin.

The 2004 Water Quality Inventory Report (LDEQ 2004) indicated that 31% of the 60 waterbody subsegments within the basin were fully supporting their three primary designated uses, while 66% of the sub segments were not supporting their designated use for fish and wildlife propagation. The suspected causes for these water quality problems include: metals, pesticides, nutrients, fecal coliform, non-native aquatic plants, organic enrichment and low concentration of dissolved oxygen, dissolved and suspended solids, pH levels, sedimentation/siltation, and turbidity. The suspected sources of the water quality problems include: non-irrigated crop production, pasture land, urban runoff, hydromodification, combined sewers and unsewered areas, surface runoff, and spills. Urban communities, home sewerage systems, and pasturelands are the primary sources of bacteria entering the Terrebonne Basin water bodies; therefore, efforts will be focused on reducing these problems. In addition, efforts should be taken to reduce the amount of sediments and nutrients entering the water bodies from agricultural lands in the upper part of the basin, in hopes that these water bodies will meet the fish and wildlife propagation use. The goal for the Terrebonne Basin as it pertains to water quality is to restore the designated uses of the basin, by reducing nonpoint source pollutant levels entering the water bodies that have been identified as not meeting water quality standards.



Land Use/Land Cover of the Terrebonne Basin

2.0 WATERSHED LAND USE

2.1 Bayou Chauvin Watershed Description

The Terrebonne Basin covers an area extending approximately 120 miles from the Mississippi River on the north to the Gulf of Mexico on the south. It varies in width from 18 miles to 70 miles. This basin is bounded on the west by the Atchafalaya River Basin and on the east by the Mississippi River and Bayou LaFourche. The topography of the entire basin is lowland, and all the land is subject to flooding except the natural "and manmade" levees along major waterways. The coastal portion of the basin is prone to tidal flooding and consists of marshes ranging from fresh to saline.

Bayou Chauvin, Ashland Canal to Lake Boudreaux, is classified as Estuarine and located at Subsegment 120507. This subsegment is tidally influenced. Water flows in either direction depending upon tides and wind conditions. The bayou conveys intermittent flow from the Houma stormwater pumps located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. This area is typical of the basin and is primarily comprised of water, wetlands and marsh. Average annual precipitation in the segment, based on the nearest Louisiana Climatic Station, is 64 inches based on a 30-year period of record (LSU, 1999).

Land Uses in Segment 120507

Land Type	Acres 120507	Percent Land use 120507
Water	7483.57	26.79
Wetland Forest Deciduous	4900.46	17.54
Brackish Marsh	4520.84	16.18
Agriculture/Cropland/Grassland	3021.23	10.81
Fresh Marsh	2321.35	8.31
Vegetated Urban	1318.35	4.72
Wetland S/S Deciduous	933.39	3.34
Wetland S/S Evergreen	236.18	0.85
Upland S/S Mixed	177.92	0.64
Non-Vegetated Urban	140.11	0.50
Upland Forest Mixed	89.85	0.32
Upland Forest Deciduous	6.00	0.02
Upland Barren	0.67	0.00

2.2 Field Survey of the Bayou Chauvin Watershed

Bayou Chauvin in Subsegment 120507 is located in the Terrebonne Basin and is approximately 8.5 miles long. A water quality survey on Bayou Chauvin was conducted on Tuesday, September 9, 2003 through Tuesday, September 16, 2003. The survey started at Woodlawn Ranch Rd. off of Hwy. 57 below Houma, and continued to Lake Boudreaux. The majority of the land use along Bayou Chauvin is wetlands. Bayou Chauvin is classified as estuarine water. There are sugarcane fields and pastures adjacent to the bayou at the upper reach of the waterbody, Ashland Landfill is located west of the bayou and north of the St. Louis Canal. In addition, there is a Terrebonne Parish oxidation pond located east of the bayou and south of the St. Louis Canal. There are no permitted dischargers located in this watershed except pump stations discharging stormwater runoff into Bayou Chauvin.

Bayou Chauvin at the upper reach section as V-shape channel

Bayou Chauvin at Woodland Dr, looking downstream, flowing downstream

The Watershed Survey Group took water quality samples throughout the length of the bayou along with In-Situ readings on September 10, 2003. In addition, a second set of samples were taken Tuesday, September 16, 2003, at main stem sites (BC02, BC05, BC07, and BC09). There was some measurable flow taken with the Acoustic Doppler just above the junction with Lake Boudreaux. A dye study was conducted at the top of the Subsegment from just below BC02 to the intersection of St. Louis Canal. The dye was dumped ¼ mile upstream from the designated point on the map because a couple of pumps were running that morning. However, the pumps shut down within an hour after the dye was dumped. There were a total of nine continuous monitors used on the survey. GPS readings were taken prior to the survey and cross sections were taken during the survey. All field observations, lab, and monitor data are available in the Bayou Chauvin TMDL Report.

Bayou Chauvin at pumps, looking downstream

Staff from the LDEQ Nonpoint Unit visited the watershed on April 9, 2008. The upper reach section of Bayou Chauvin, especially around and on the southeast corner of the city of Houma, appears to be more densely populated. The mid section of Bayou Chauvin is neighbored by small commercial/industrial areas, and meanders pass the Houma Terrebonne Regional Airport further south from the city. The lower mid section of the bayou consists mainly of agriculture landuse such as sugarcane and pasture, with very little impacts from human or urban developments. A rather new residential subdivision is surrounded on all sides by agricultural land probably caused by land conversion from agricultural use to residential.

Bayou Chauvin at pumps, looking upstream

Landuse transition and water quality impacts become very apparent at the crossing of Woodlawn Bridge on Bayou Chauvin. The Houma pump station is located on the bayou about 2-3 miles south of the Woodlawn Bridge. Bayou Chauvin is classified as a wetland or estuarine water south of the pump station. There are no permitted dischargers located in this Subsegment except pump stations discharging stormwater into the bayou.

Pump discharge structure –Left

Pump discharge structure –Middle

Pump discharge structure –Right. No bypass – All flow is pumped

Neither Terrebonne nor Lafourche Parish has public community sewerage systems in this watershed. Except for a few isolated mobile home parks that may have small private community systems, most communities in the watershed are connected to individual septic tanks, cesspools, or Aerobic Treatment Units. Although some of these may treat on-site, it is likely that some discharges to the Bayou.

3.0 WATER QUALITY ANALYSIS

3.1 Water Quality Data

A water quality standard is a definite numerical criterion value or general criterion statement to enhance or maintain water quality and to provide for, and fully protect, the designated uses of a waterbody (LDEQ, 2003). The ability of a waterbody to support its designated uses is determined by water quality criteria. Criteria are elements of water quality which set general and numerical limitations on the permissible amounts of a substance or other characteristics of state waters. General and numerical criteria are established to promote restoration, maintenance, and protection of state waters. A criterion for a substance represents the permissible levels for that substance at which water quality will remain sufficient to support a designated use. A complete list of water quality criteria can be found in the Louisiana Administrative Code, Title 3, Part IX, Subpart 1, Chapter 11, Section 1113. A non-inclusive sample of numerical criteria can be found in Table 3.

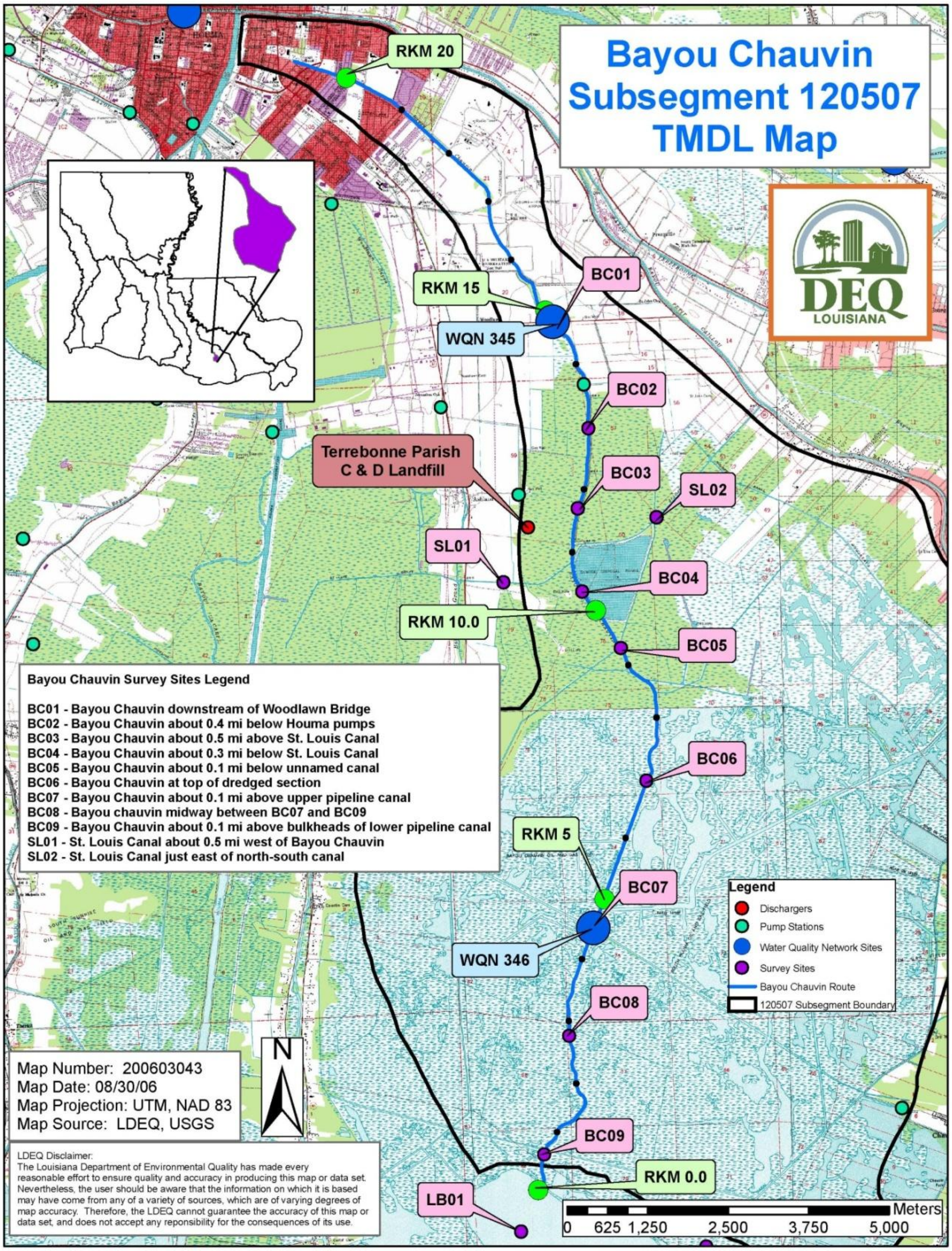
Water Quality Numerical Criteria for Bayou Chauvin in Subsegment 120507

Water Quality Parameter	Numerical Criteria
Designated Uses	A B C
Dissolved Oxygen, mg/L	4.0
Chlorides. mg/L	N/A
Sulfates mg/l	N/A
pH	6.5 – 9.0
BAC	1*
Temperature, ° C	32
Total Dissolved Solids, mg/L	N/A

USES: A – primary contact recreation; B - secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply; E – oyster propagation; F – agriculture; G – outstanding natural resource water; L – limited aquatic life and wildlife use.

**Note 1 – 200 colonies/100mL maximum log mean and no more than 25% of samples exceeding 400 colonies/100mL for the period May through October; 1,000 colonies/100 mL maximum logs mean and no more than 25% of samples exceeding 2,000 colonies/100mL for the period November through April.*

Map of Study Area



LDEQ maintained two sampling locations (0345 & 0346) on Bayou Chauvin as part of the Statewide Water Quality Monitoring Network. Data was collected on a monthly basis in 2000, 2005 and 2006. The first Ambient Network Station Number 58010345 is located at the Woodlawn Ranch Road south of Houma, Louisiana. This site is located at Latitude 29°33'15", Longitude 90°39'38" in Section 20, Township17, and South Range 18 East. The second Ambient Network Station Number 58010346 is located south of the city of Houma, at about 2.5 miles north of Lake Boudreaux. This site is located at Latitude 29°28'10", Longitude 90°39'21" in Section 73, Township18, and South Range 18 East. Refer to Appendix A for ambient water quality data. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year.

If samples taken through the ambient sampling program fail to meet water quality criteria, a water body is considered impaired for the designated use(s) to which those criteria apply. Waters of the state are assessed biennially in the Louisiana Water Quality Inventory Integrated Report. This report includes the 303(d) list of impaired water bodies. Bayou Chauvin in Subsegment 120507 has been listed on the 1999, 2002, and 2004 303(d) lists of impaired water bodies. In the 2006 303(d) list, the Bayou Chauvin is fully supporting Primary and Secondary Contact Recreation and is not supporting Fish and Wildlife Propagation. Bayou Chauvin in Subsegment 120507 is found to be not supporting the designated uses of fish and wildlife propagation and shellfish propagation. The suspected causes of impairment are low dissolved oxygen and nutrients. The suspected sources are municipal point source discharges, small flow discharges, sanitary sewer overflows, and total retention domestic sewage lagoons.

The sampling schedule for the four year cycle is shown below:

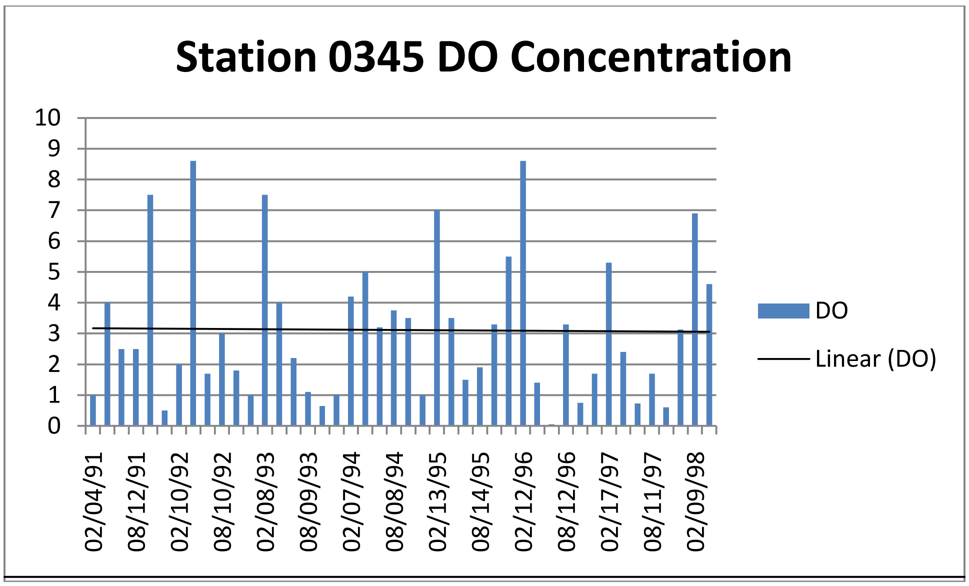
TMDL Sampling Schedule

Basin	First 4-Year Cycle	Second 4-Year Cycle
Mermentau	2004, 2005, 2006, 2007	2008, 2009, 2010, 2011
Vermilion-Teche	2004, 2005, 2006, 2007	2008, 2009, 2010, 2011
Calcasieu River	2004,2005	2008,2009
Ouachita River	2004,2005	2008,2009
Barataria	2004,2005	2008,2009
Terrebonne	2004,2005	2008,2009
Mississippi River	2004,2005	2008,2009
Lake Pontchartrain	2006,2007	2010,2011
Pearl River	2006	2010
Red River	2004,2005,2006,2007	2008,2009,2010,2011
Sabine River	2006,2007	2010,2011
Atchafalaya River	2004,2005	2008,2009

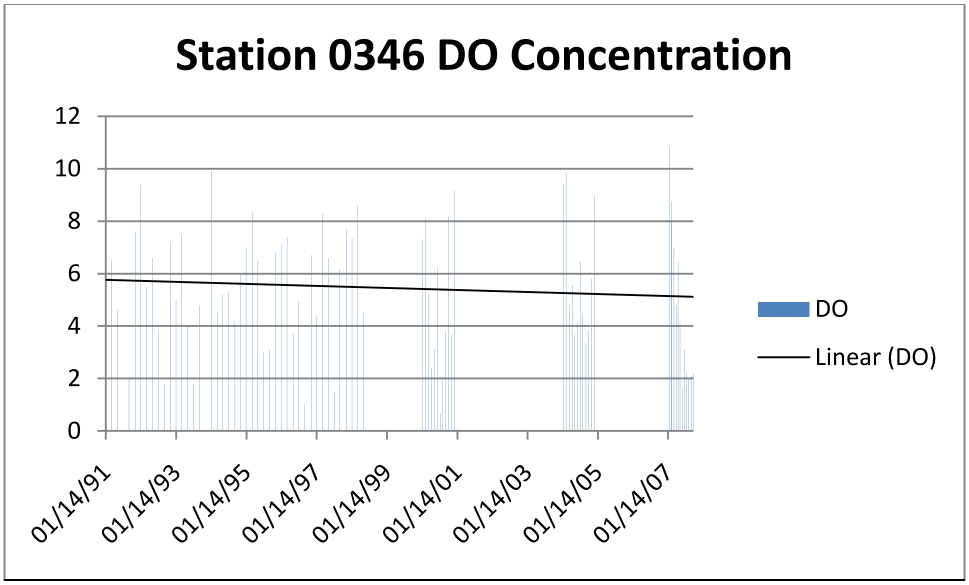
DISSOLVED OXYGEN, DO

The water body was listed as not supporting fish and wildlife propagation due to low dissolved oxygen concentrations and nutrient enrichment. The 2008 Integrated Report listed the water use impairments for fish and wildlife propagation as municipal point sources, package plants or other small permitted flows, sanitary water overflows, collection system failures, total retention domestic sewage lagoons, and introduction of non-native aquatic plants.

From the graph below, the trend analysis of Dissolved Oxygen for Bayou Chauvin Ambient Network Station Number 58010345 located at the Woodlawn Ranch Road south of Houma shown a slight decreasing trend from 1991 to 1998. The average DO concentration observed at this station was about 3 mg/l.

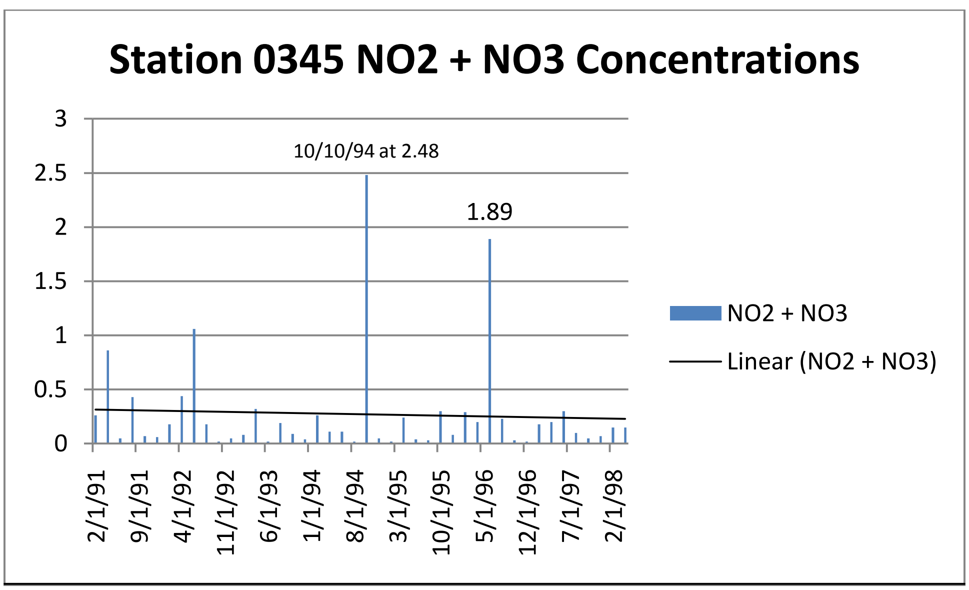


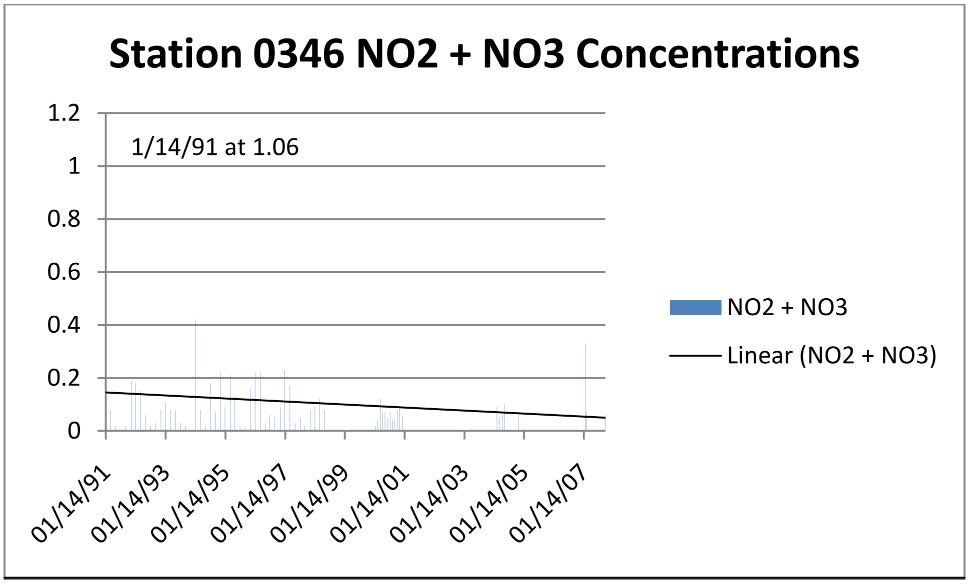
When the same analysis was performed for Bayou Chauvin at Ambient Network Station Number 58010346 located south of the city of Houma, at about 2.5 miles north of Lake Boudreaux, a slightly bigger decreasing trend of Dissolved Oxygen concentrations were recorded. The sampling period for this analysis was from 1991 to 2007. The decreasing trend of DO is from the high of about 6 ppm in 1991 to a low of about 5 ppm in 2007. The average DO concentrations at this location were about twice as high at 6 ppm than that of Station 0345 located in Houma. Data gaps were observed at this location due to a 4 year rotation cycle administered by LDEQ.



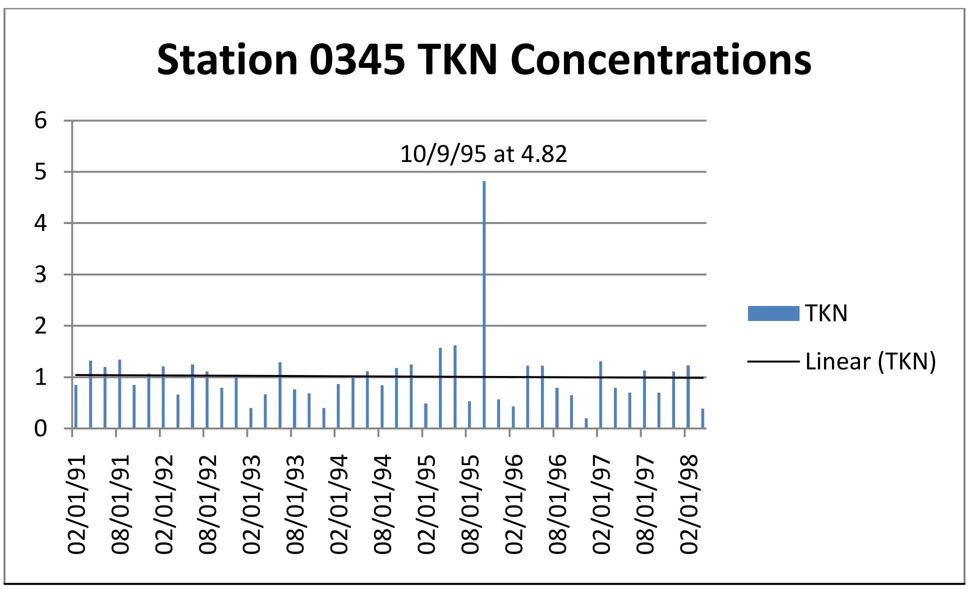
NUTRIENT, NO2+NO3, TKN, TP

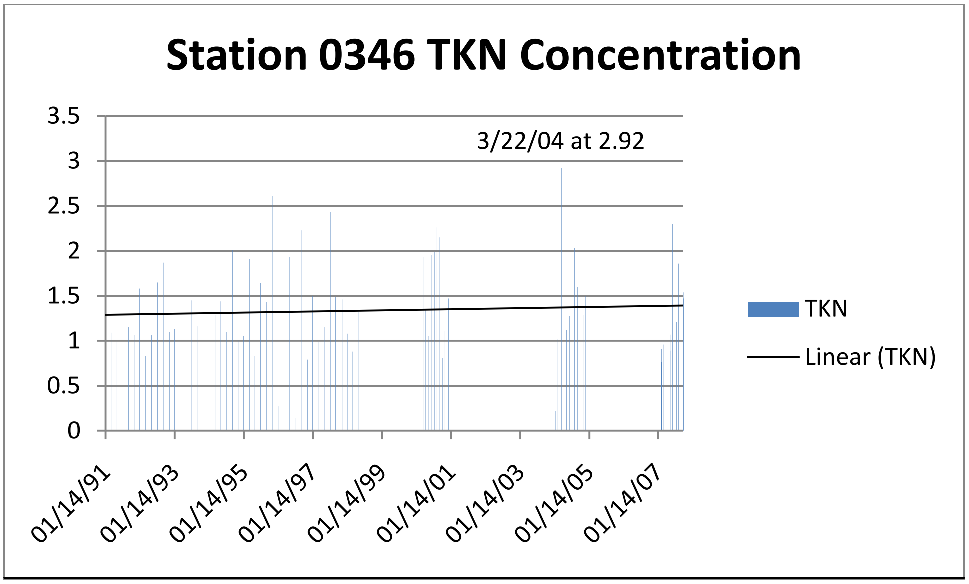
Analyses of nutrient parameters at both Ambient Network Stations located in the Bayou Chauvin watershed indicated decreasing trends for all but TKN and TP at Station 0346. Station 0345 average NO2+NO3 concentration was 0.27 ppm and 0.11 ppm for that of Station 0346. This indicated a decrease of more than ½ of that of the NO2+NO3 concentrations for Station 0345 in Houma. The decrease of NO2+NO3 concentrations in downstream Bayou Chauvin could be associated with lesser impacts from human population.



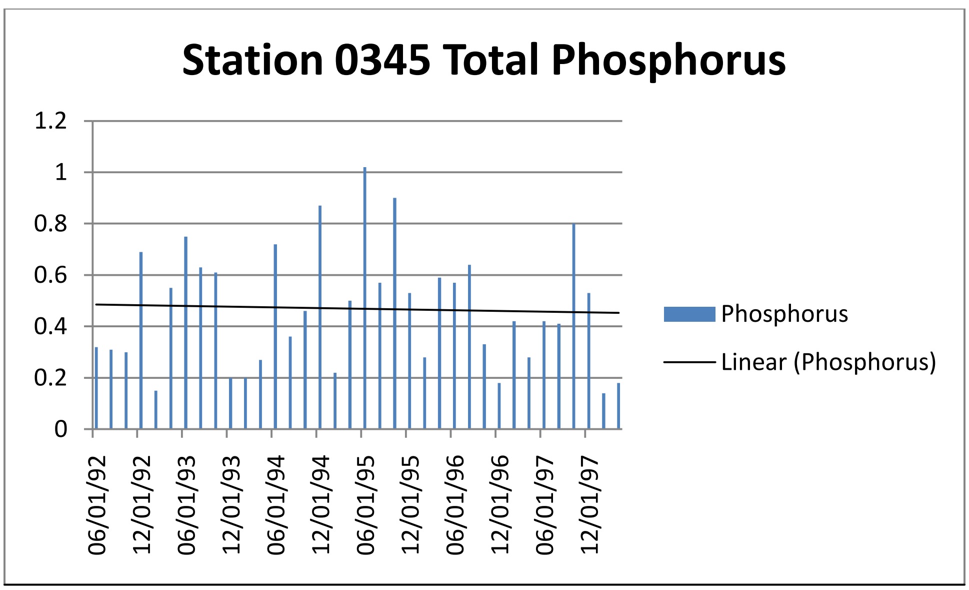


The average TKN concentration for Station 0345 was 1.01 ppm. A spike TKN concentration of 4.82 ppm was recorded on 10/9/1995. By removing this spike, the average TKN concentration for the period was reduced to 0.93 ppm.

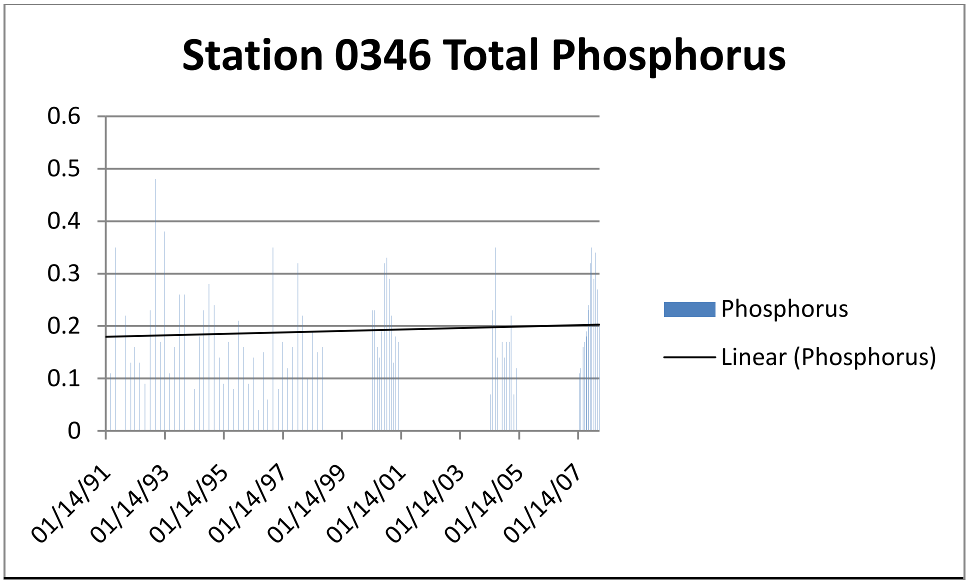




The average TKN concentration for Station 0346 was 1.34 ppm. An increasing trend of TKN concentration was recorded from the low of about 1.3 ppm in 1991 to a high of close to 1.5 ppm in 2007. Data gabs were displayed due to 4-year sampling collection rotations. Analyses of historical TKN data on Bayou Chauvin appeared to indicate higher downstream TKN concentrations.



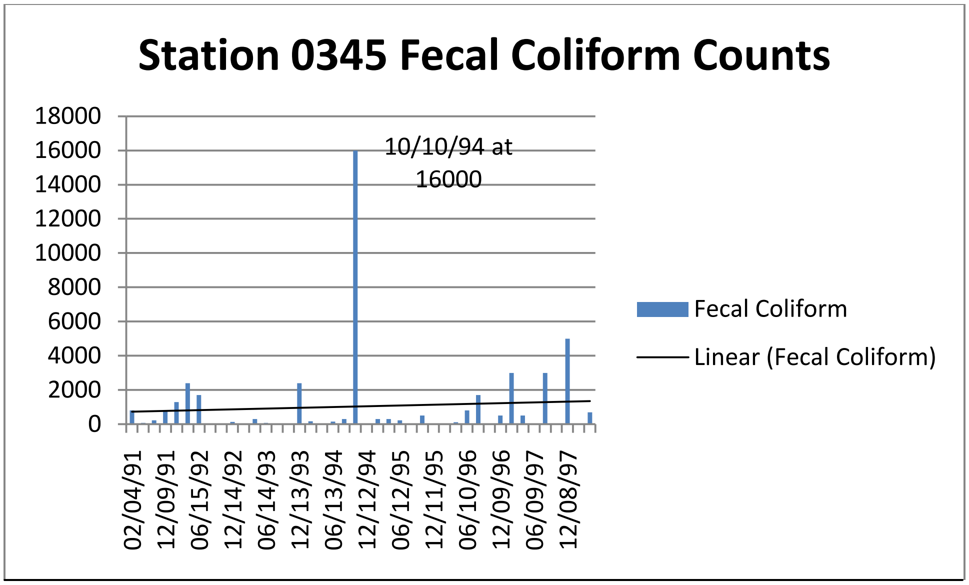
Total phosphorus for Station 0345 depicted a slight decreasing trend from a high of about 0.5 ppm in 1992 to a low of about 0.45 ppm in 1997. The average TP concentration for this period was 0.47 ppm.



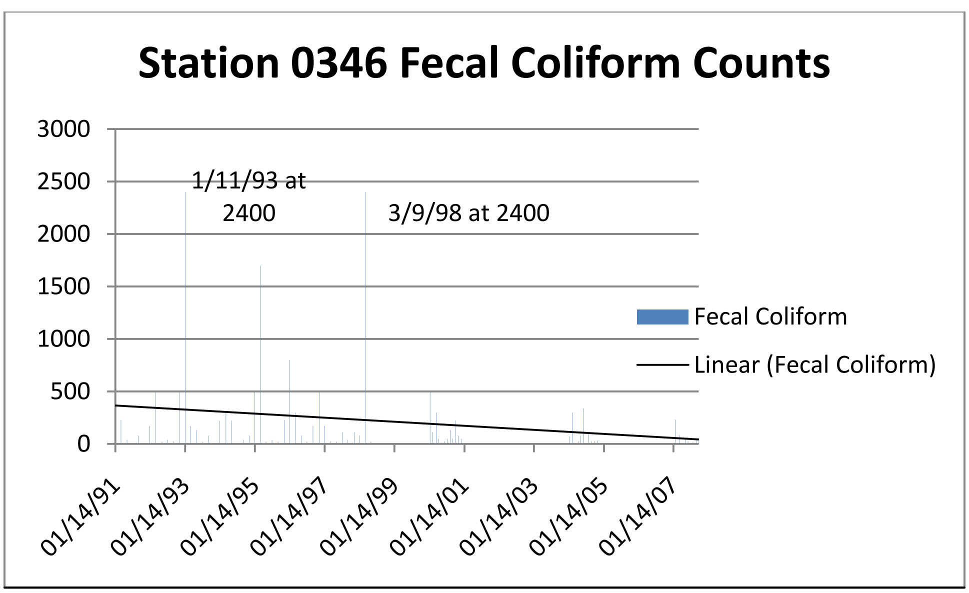
For Station 0346, TP concentrations appear to indicate an increasing trend from a low of less than 0.2 ppm in 1991 to a high of 0.2 ppm in 2007. The average TP concentration for this period was 0.19 ppm. Data gabs also shown on graph from 1997 to 2007 due to a 4 year collection rotation. Review of the historical data for Bayou Chauvin indicated a much improve TP concentration downstream, an improvement from 0.47 ppm at Station 0345 in Houma to 0.19 ppm at Station 0346 near Lake Boudreaux. Again, this observation could be associated with lesser human population downstream on Bayou Chauvin Watershed.

FECAL COLIFORM, FC

Fecal coliform counts for Ambient Network Station 0345 at Houma demonstrated an increasing trend from 1991 to 1997. The average fecal count for this period is 2,036 MPN/100 ml. A spike of 160,000 MPN/100 ml was observed on 10/10/1994 could be associated with impacts from hurricane or tropical depression moving inland. If this pike was removed from the calculation, the average fecal count reduced to 1,322 MPN/100ml.



However, the fecal coliform concentrations for Ambient Network Station 0346 north of Lake Boudreaux demonstrated a decreasing trend from 1991 to 2007. The average fecal concentration for this period was 414 MPN/100ml. During this period, twice the fecal coliform counts were the highest at 2,400 MPN/100ml on 1/11/1993 and 3/9/1998 respectively. Fecal coliform concentrations for Station 0345 near Houma was about 5 times higher than that of fecal coliform counts for Station 0346 near Lake Boudreaux. The difference in fecal coliform concentrations can be associated with denser population near Houma, and the effects of failing septic tank systems contributing to water quality degradation upstream on Bayou Chauvin watershed.



4.0 TMDL FINDINGS

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for impaired waterbodies. A TMDL establishes the amount of a pollutant that a waterbody can assimilate without exceeding its water quality standard for that pollutant. TMDLs provide the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody and may include a future growth (FG) component. The TMDL components are illustrated using the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS + FG$$

4.1 TMDL for biochemical oxygen-demanding pollutants

TMDL establishes load limitations for oxygen-demanding substances and goals for reduction of those pollutants. When oxygen-demanding substances are controlled and limited in order to ensure that the dissolved oxygen criterion is supported, nutrients are also controlled and limited. The implementation of this TMDL through wastewater discharge permits and implementation of best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will also control and reduce the nutrient loading from those sources.

A calibrated water quality model for the watershed was developed and projections were modeled to quantify the nonpoint source load reductions which would be necessary in order for Bayou Chauvin, subsegment 120507 to comply with its established water quality standards and criteria. The model extends from site BC01 at RKM 14.7 to its confluence with Lake Boudreaux. Modeling was limited to low flow scenarios since the constituent of concern was dissolved oxygen and the available data was limited to low flow conditions. The dissolved oxygen level in Lake Boudreaux at it's confluence with Bayou Chauvin is extremely low. This is believed to be primarily due to the stormwater drainage from the Houma stormwater pumps.

The results of the projection modeling for subsegment 120507 show that the water quality standard of 4.0 mg/l for dissolved oxygen can be maintained during the summer critical season with a 43% reduction of total nonpoint pollution. The minimum DO is 4.39 mg/l. Background loading could not be calculated because there were no reference stream studies available for this area.

Total Maximum Daily Load (Sum of UCBOD[1], UNBOD, and SOD)

ALLOCATION	SUMMER		WINTER	
	% Reduction Required	(MAR-NOV) (lbs/day)	% Reduction Required	(DEC-FEB) (lbs/day)
Point Source WLA	0	0	0	0
Point Source Reserve MOS (20%)	0	0	0	0
Manmade Nonpoint Source LA	43	21,106	43	18,282
Manmade Nonpoint Source Reserve MOS(20%)	0	5,277	0	4,571
TMDL		26,383		22,853

***Note1: UCBOD as stated in this allocation is Ultimate CBOD.
UCBOD to $CBOD_5$ ratio = 2.3 for all treatment levels
Permit allocations are generally based on $CBOD_5$***

The results of the projection modeling for subsegment 120507 show that the water quality standard of 4.0 mg/l for dissolved oxygen can be maintained during the winter critical season with the same 43% reduction of total nonpoint pollution. The minimum DO is 6.17 mg/l in subsegment 120507. The TMDL is presented in Table 2.and a summary of the land uses in subsegment 120507 is presented in Table 1.

Bayou Chauvin conveys intermittent flow from the Houma stormwater pumps located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. It is believed that stormwater conveyed by the bayou is primarily responsible for violations of dissolved oxygen criteria. The DO becomes lower towards the bottom at the confluence with Lake Boudreaux due to settling combined with tidal influence. The high chlorides and conductivity values are characteristic of tidal waterbodies. The high chlorophyll a is indicative of the algae blooms present in open waters. Houma is considering moving the stormwater pumps to Bayou Terrebonne which would likely enhance the water quality of Bayou Chauvin. As stated above, no permitted dischargers are located in this subsegment. There is significant oil and gas activity, but these facilities are no longer allowed to discharge into waters of the state. Additionally, the Houma South Wastewater Treatment Plant, though located in this subsegment, discharges to the Houma Navigation Canal and does not impact Bayou Chauvin.

5.0 SOURCES OF NONPOINT SOURCE POLLUTION LOADING AND IDENTIFICATION OF HIGH PRIORITY AREAS

Section 319 of the Clean Water Act was enacted to specifically address problems related to NPS pollution. The objective of the Act is to restore and maintain the chemical, physical and biological integrity of the nation's water. Nonpoint source pollution often results from many different sources with no specific solution to rectify the problem. Therefore, to be able to identify all types of landuse and land coverage areas within the watershed is the key to managing the sources of nonpoint source pollution. Landuse activities such as agriculture, cilviculture, urban, and hydromodification, can contribute to pollutant loads into receiving waterbody.
Bayou Chauvin, subsegment 120507, is listed on the 2006 court ordered 303(d) list for not meeting water uses for fish and wildlife propagation. Bayou Chauvin is currently meeting water quality uses for primary contract recreation and secondary contract recreation. The suspected causes of impairments are low level of dissolved oxygen concentration, elevated NO2 and NO3 concentration and total phosphorus exceeding the acceptable criteria. The suspected sources of impairment for Bayou Chauvin are sanitary sewer overflow, municipal point source discharges, package plant or other permitted small flow discharges, and total retention domestic sewage lagoon. Nonpoint source pollution in Bayou Chauvin watershed according to the 2006 303(d) list is primarily due to home sewage. The recently approved TMDL report by EPA on Bayou Chauvin watershed indicated no permitted discharges located in this watershed except pump stations discharging stormwater runoff. Bayou Chauvin conveys intermittent flow from the City of Houma stormwater pump stations located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. It is believed that the stormwater conveyed by the bayou is primarily responsible for the violations of dissolved oxygen criteria. The DO becomes lower towards the bottom at the confluence with Lake Boudreaux due to settling combined with tidal influence. The City of Houma is considering moving the stormwater pumps to Bayou Terrebonne which would likely enhance the water quality of Bayou Chauvin. There is significant oil and gas activity, but these facilities are no longer allowed to discharge into waters of the state. Additionally, the Houma South Wastewater Treatment Plant, though located in this subsegment, discharges to the Houma Navigation Canal and does not impact Bayou Chauvin watershed.

5.1 Agriculture

Very little agricultural activities were observed in this watershed. The percentage of land use coverage area for agriculture/cropland/grassland according to the 2005 land use/land cover assessment is at 10.81%. Agriculture is mostly concentrated within the mid section of Bayou Chauvin, located south of the city of Houma. The primary crop is sugarcane, but pasture is also a key agricultural product in this watershed.

State water quality assessments continue to show that nonpoint source pollution is the leading cause of impairments in surface waters of the U.S. According to these assessments, agriculture is the most wide-spread source of pollution for assessed rivers and lakes. Agriculture impacts 18% of assessed river miles and 14% of assessed lake acres. The state reports also indicate that agriculture impacts 48% of impaired river miles and 41% of impaired lake acres (EPA, 2002).

The primary agricultural NPS pollutants are nutrients, sediment, animal wastes, salts, and pesticides. Agricultural activities also have the potential to directly impact the habitat of aquatic species through physical disturbances caused by livestock or equipment. Although agricultural NPS pollution is a serious problem nationally, a great deal has been accomplished over the past several decades in terms of sediment and nutrient reduction from privately-owned agricultural lands. Much has been learned in the recent past about more effective ways to prevent and reduce NPS pollution from agricultural activities.

5.1.1 Sugarcane

Sugarcane is considered a row crop and soil tillage is the most common form of practice for preparing this type of row crop agriculture. When rain occurs, the soil can be easily washed into the receiving waterbody. Sediment runoff often laden with fertilizer, pesticides, herbicides and insecticides can result in nonpoint source pollutant loading into the river. Most rivers, streams, and bayous in Louisiana are small gradient and low flow; the nonpoint source load can deposit and accumulate on the stream bottom. Warm temperatures increase the rate pollutants degrade, consuming dissolved oxygen in the receiving waters.

Most agricultural fields are cultivated all the way to the edge of the stream, with no filter strip or buffer zone for treatment of runoff from the fields. The edge of field and drainage ways are often sprayed with herbicides and kept barren, offering no conservation practices of nutrient and soil loss. These bare stream banks, streams, canals or drainage ditches can result in stream bank erosion, contributing to nonpoint source pollution into the receiving waters.

5*.1.2 Pastureland*

Pasture requires a large amount of fertilizer in order to provide a healthy food supplies and for the production of hay. Excessive use of fertilizer and untimely applications of nutrients, can contribute to runoff of nonpoint source pollutants into receiving waters. When livestock are allowed access to stream bank, it increases stream bank erosion and the deposition of fecal bacteria into rivers or bayous, resulted in low dissolved oxygen concentrations and elevated fecal coliform counts in the receiving stream. Sediment runoff into rivers also increases turbidity of water, thereby reducing light penetration, impairing photosynthesis, altering oxygen relationship which in turn reduces food supplies to certain aquatic organisms. Increase sediments also fill bayous, lakes and shipping channels resulted in loss of economic values.

5.2 Urban and Suburban Development Impacts

Although there is very little urbanized areas in the Bayou Chauvin watershed, urban and suburban developments are considered to be the most significant contribution to nonpoint source impairments. The conversion of other land use types to residential or urban developments also impacted greatly on water quality throughout the United States. Based on the 2005 land use/land cover assessment, Bayou Chauvin in Subsegment 120507 identified 4.72% landuse as vegetated urban and 0.50% land use as non-vegetated urban. Urban and suburban areas are concentrated within the upper reach of Bayou Chauvin, far north from the flood control levies downstream.

The process of urbanization increases impervious surface areas, such as roof tops, streets, parking lots and sidewalks where water can not infiltrate. Urbanization also disturbs natural and land cover and alters natural drainage patterns. All these factors lead to an increase in the quantity and velocity of runoff, leading to an increase in erosion potential as well as flooding. Pollutants that are present between rainfall events in the atmosphere prior to a storm and which accumulate on imperious surfaces are generally carried away in moderate to heavy storms. Urban nonpoint source pollution is the result of precipitation washing the surfaces of urbanized areas. As precipitation falls on urban areas, it picks up contaminants from the air, littered and dirties streets and sidewalks, petroleum residues from automobiles, exhaust products, heavy metal and tar residuals from roads, chemicals applied for fertilization, weed and insect controls, and sediments from construction site. The dumping of chemicals such as used motor oil and antifreeze into storm sewers is another source of urban/suburban nonpoint source pollution. Other sources of urban NPS pollution could be related to illegal hookup of storm drains to sanitary sewer, causing increase volume of flow to waste water treatment plant, leading to more frequent overflow of sewage into receiving waterbodies.

5.3 Onsite Disposal Systems (Septic Tanks) Impacts

The 2006 303(d) list identified sanitary sewer overflows as a leading source of impairment to fish and wildlife propagation in the Bayou Chauvin watershed. Treating human waste with an approved, properly maintained sewage treatment system is required of all homes, camps, and businesses, and is a major step in maintaining a purity of surface and ground waters. In areas not connected to a municipal treatment system, the most common treatment method is the conventional septic tank leach line system. Septic tank system consists of two major components: a treatment unit or septic tank and a disposal unit or soil absorption system. Failing individual waste disposal system whether due to lack of septic tank maintenance, poor design, improper installation or soil type suitability, is a major sources of nonpoint source pollution. Improperly maintained septic systems can contaminate ground water and surface water with nutrients and pathogens. Ensuring that the septic system continues to function properly is important in reducing leaks and potential nonpoint source pollution.

Another component to the pollution caused by onsite disposal systems is the inadequate enforcement of the State Sanitary Code. No disposal system should be installed without first obtaining a permit from the State Health Officer. The Department of Health and Hospitals regulations describe the acceptable capacities, materials, and construction of septic tanks, field lines, sand filters and oxidation ponds.

2006 303 (d) List of Suspected Causes and Sources of Impairments

Subsegment Number	Subsegment Description	PCR	SCR	FWP	Impaired Use for Suspected Cause	Suspected Causes of Impairment	Suspected Sources of Impairment
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Nitrate/Nitrite (Nitrite + Nitrate as N)	Municipal Point Source Discharges
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Nitrate/Nitrite (Nitrite + Nitrate as N)	Package Plant or Other Permitted Small Flows Discharges
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Nitrate/Nitrite (Nitrite + Nitrate as N)	Sanitary Sewer Overflows (Collection System Failures)
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Nitrate/Nitrite (Nitrite + Nitrate as N)	Total Retention Domestic Sewage Lagoons
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Oxygen, Dissolved	Municipal Point Source Discharges
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Oxygen, Dissolved	Package Plant or Other Permitted Small Flows Discharges
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Oxygen, Dissolved	Sanitary Sewer Overflows (Collection System Failures)
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Oxygen, Dissolved	Total Retention Domestic Sewage Lagoons

LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Phosphorus (Total)	Municipal Point Source Discharges
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Phosphorus (Total)	Package Plant or Other Permitted Small Flows Discharges
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Phosphorus (Total)	Sanitary Sewer Overflows (Collection System Failures)
LA120507_00	Bayou Chauvin-Ashland Canal to Lake Boudreaux (Estuarine)	F	F	N	FWP	Phosphorus (Total)	Total Retention Domestic Sewage Lagoons

6.0 NONPOINT SOURCE POLLUTION SOLUTIONS

6.1 Agriculture

The primary agricultural nonpoint source pollutants are nutrients, sediment, animal wastes, and pesticides. Agricultural activities also have the potential to directly impact the habitat of aquatic species through physical disturbances caused by livestock or equipment. Although agricultural NPS pollution is a serious problem nationally, a great deal has been accomplished over the past several decades in terms of sediment and nutrient reduction from privately-owned agricultural lands. Much has been learned in the recent past about more effective ways to prevent and reduce NPS pollution from agricultural activities. The implementation of agricultural management measures will reduce the generation on nonpoint source pollutants from agricultural activities and minimize the transport of pollutants from agricultural land to surface and ground waters.

Agricultural Best Management Practices, BMPs

BMPs are designed to enhance the sustainability of agricultural resources and minimize the impact caused by modern agricultural techniques.

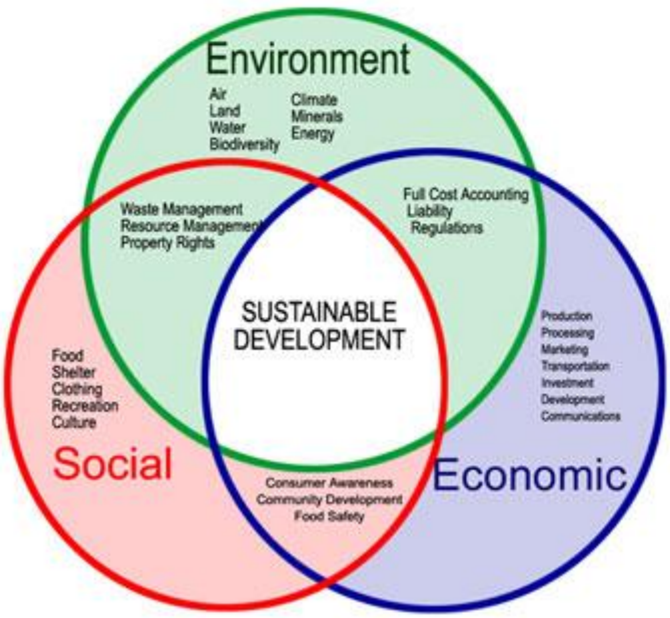
In general, there are four fundamental types of agriculture BMPs, these are:

1. **Input Reduction -** Reducing inputs of chemicals, fertilizers, manures and pesticides, foreign microbes, sediments, etc. is a key element of agricultural BMP's. The less a potentially harmful substance is used in agriculture, the less likely it is to affect other parts of the environment.
2. **Nutrient management -** limiting the amount of fertilizer such that it does not exceed what the crop can absorb and use. Applications of materials in excessive quantities may find their way to enter surface and ground water.
3. **Integrated Pest Management -** is a management strategy that includes an understanding of the target pest and use of a combination of physical, chemical, biological and cultural controls. Proper storage, mixing and handling of pesticides are also essential in minimizing risk to the environment.
4. **Control Erosion and Runoff -** particularly on the prairies, excess spring runoff can lead to extensive flooding. To counteract this many techniques may be

employed - shelterbelts, retention ponds, continuous cropping, etc. Grassed waterways (swamps / bogs / deltas) can trap sediments and can filter out noxious chemicals.

Sustainable Agriculture

Some of the most negative impacts of agricultural practices can be mitigated through BMPs. However, in order to be truly sustainable over the long term, soil, air and water quality all must be maintained.



Overall, best management practices vary in effectiveness and cost potential. Implementing effective and sustainable BMP's is the real challenge.

Precision Farming to Control Nonpoint Pollution from Agriculture

The Precisely Tailored Practice

Precision farming, also known as site-specific management, is a fairly new practice that has been attracting increasing attention both within and outside the agricultural industry over the past few years. It is a practice concerned with making more educated and well-informed agricultural decisions. Precision farming provides tools for tailoring production inputs to specific plots (or sections) within a field. The size of the plots typically ranges from one to three acres, depending on variability within the field and the farmer's preference. By treating each plot as much or as little as needed, farmers can potentially reduce the costs of seed, water, and chemicals; increase overall crop yields; and reduce environmental impacts by better matching inputs to specific crop needs. Rather than applying fertilizer or pesticides to an entire field at a single rate of application, farmers first test the soil and crop yields of specific plots and then apply the appropriate amount of fertilizer, water, and/or chemicals needed to alleviate the problems in those sections of the field. Precision farming requires certain technology, which is an added cost, as well as increased management demands.

Precision farming is changing the way farmers think about their land. They are increasingly concerned not with the average needs of the entire field, but with the actual needs of specific plots, which can fluctuate from one square meter to the next. The practice of precision farming acknowledges the fact that conditions for agricultural production vary across space and over time. With this in mind, precision farmers are now making management decisions more specific to time and place rather than regularly scheduled and uniform applications.

The Computer-Aided Approach

The approach of precision farming involves using a wide range of computer-related information technologies, many just recently introduced to production agriculture, to precisely match crops and cultivation to the various growing conditions. The key to successfully using the new technologies available to the precision farmer to maximize possible benefits associated with this approach is information. Data collection efforts begin before crop production and continue until after the harvest. Information-gathering technologies needed prior to crop production include grid soil sampling, past yield monitoring, remote sensing, and crop scouting. These data collection efforts are even further enhanced by obtaining precise location coordinates of plot boundaries, roads, wetlands, etc., using a global positioning system (GPS).

Other data collection takes place during production through “local” sensing instruments mounted directly on farm machinery. Variable rate technology (VRT) uses computerized controllers to change rates of inputs such as seed, pesticides, and nutrients through planters, sprayers, or irrigation equipment. For example, soil probes mounted on the front of fertilizer spreaders can continuously monitor electrical conductivity, soil moisture, and other variables to predict soil nutrient concentrations and accordingly adjust fertilizer application “on-the-fly” at the rear of the spreader. Other direct sensors available include yield monitors, grain quality sensors, salinity meter sleds, weather monitors, and spectroscopy devices. Optical scanners can be used to detect soil organic matter, to recognize weeds, and to instantaneously alter the amount or application of herbicides applied.

The precision farmer can then take the information gathered in the field and analyze it on a personal computer. The personal computer can help today’s farmer organize and manage the information collected more effectively. Computer programs, including spreadsheets, databases, geographic information systems (GIS), and other types of application software, are readily available. By tying specific location coordinates obtained from the GPS in with the other field data obtained, the farmer can use the GIS capability to create overlays and draw analytical relationships for site-specific patterns of soils, crop yields, input applications, drainage patterns, and other variables of interest over a particular distance or time period.

GIS can also be integrated with other decision support systems (DSS), such as process models and artificial intelligence systems, to simulate anything from crop growth and financial expectations to the generation and movement of nutrients and pesticides through the environment. Today's precision farmer can also use expert systems, information systems based on input from human experts, to retrieve advice on when to spray for specific pests, when to till, and so forth. These systems are continuously modified for the farmer's field based on past, current, and expected conditions represented by soil, weather, pest level, and other data input from the GIS.

The Technology-Driven Future

Further technological advances will make the coming years decisive for the precision farming industry. There's no saying what the future holds for this new era of agricultural production. Listed below are just a few of the technological advances projected to hit the agriculture industry in the years to come:

- Onboard grain quality analyzers will check both physical and chemical attributes (including smell);
- High-precision soil testing will move from the lab to the field, with fiber optic spectrometers attached to real-time onboard computers;
- Micro-ecology will be tested along with water runoff and air samples;
- Immunochemical assays will measure chemical residues on leaf surfaces or monitor plant health and productivity;
- A wide range of sensors, monitors, and controllers such as shaft monitors, pressure transducers, and servo motors will be used to collect accurate data;
- Weather monitors will be mounted on sprayers, or "talk" directly to local weather station networks as they simultaneously change droplet size or spray patterns, as well as rates and products, on the go;
- Remote imaging technologies will be used to assess crop health and management practice implementation;
- Guidance on control systems will guarantee straight rows, control depth, and optimize inputs;
- Crop models will optimize economic and environmental variables. Farmers will buy insurance directly from the underwriter, who will also rely on remote sensing and risk modeling; and
- Wearable computers with voice recognition and head-mounted displays will guide farmers through equipment maintenance and crop scouting.

Although precision farming has not yet been widely adapted to date, this practice continues to attract increasing attention both on and off the farm. Much of the off-the-farm enthusiasm for precision farming can be attributed to the eminent good sense of matching input application to plant needs. Precision farming is simply a more finely tuned version of the kinds of BMPs already recommended at the field level. Because this technology is still somewhat new to the industry, there is much more to learn about the potential overall impact of precision farming on water quality relative to conventional techniques. But one thing is certain: precision farming has the potential to enhance economic return (by cutting costs and raising yields) and to reduce environmental risk (by reducing the impacts of fertilizers, pesticides, and erosion).

6.2 Urban Area Management Measures

People and their actions are the most significant sources and causes of urban runoff and pollution. Uncontrolled or treated runoff from the urban environment and from construction activities can run off the landscape into surface waters. This runoff can include such pollutants as sediments, pathogens, fertilizers/nutrients, hydrocarbons, and metals. Pavement and compacted areas, roofs, reduced tree canopy, and open space increase runoff volumes that rapidly flow into our waters. This increase in volume and velocity of runoff often causes stream bank erosion, channel incision, and sediment deposition in stream channels. In addition, runoff from these developed areas can increase stream temperatures that along with the increase in flow rate and pollutant loads, negatively affect water quality and aquatic life.

Other common sources of urban pollution include improperly sited, designed, and maintained onsite wastewater treatment (septic) systems, pet wastes, lawn and garden fertilizers and pesticides, household chemicals that are improperly disposed of, automobile fluids, road deicing/anti-icing chemicals, and vehicle emissions.

The following information is a summary of the management measures described in the USEPA guidance document, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, 2005 (http://www.epa.gov/owow/nps/urbanmm/). This guidance helps citizens and municipalities in urban areas protect bodies of water from polluted runoff that can result from everyday activities. These scientifically sound techniques are the best practices known today. The guidance will also help states to implement their NPS control programs and municipalities to implement their Phase II Stormwater Permit Programs.

The implementation of management measures for urban runoff will reduce the generation of nonpoint source pollutants from existing development and control runoff and treat pollutants associated with new development and redevelopment. The implementation of the following management measures will also result in more consistent and widespread implementation of existing state NPS programs.

Pollutants Typically Found in Urban Runoff

COMMON URBAN RUNOFF POLLUTANT	SOURCE	AVERAGE CONCENTRATE	NONPOINT SOURCE IMPACTS
Sediment	Urban/ Suburban	80 mg/l Average	Fills in ponds and reservoirs with mud; contributes to decline of submergent aquatic vegetation by increasing turbidity and reducing the light available for photosynthesis, and covers or reduces spawning beds.. Acts as a sink for nutrients and toxicants and as a source when disturbed and resuspended.
Total Phosphorus	Urban/ Suburban	1.08 mg/l 0.26 mg/l	A contributing factor cited in eutrophication (nutrient over-enrichment) in receiving water bodies and subsequent algal blooms. Algal blooms contribute to the decline of submerged aquatic vegetation by reducing light available for photosynthesis, further degrade water quality by decreasing the level of dissolved oxygen (DO), increase Biological Oxygen Demand (BOD), and may cause changes in the composition of plankton and fish species.
Total Nitrogen	Urban/ Suburban	13.6 mg/l 2.00 mg/l	Like total phosphorus, contributes to eutrophication and algal blooms, though more typically in salt water bodies.
Chemical Oxygen Demand(COD)	Urban/ Suburban	163.0 mg/l 35.6 mg/l	Decreases the concentration of dissolved oxygen (DO). Low DO concentration and anaerobic conditions (complete absence of DO) can lead to fish kills and unpleasant odors. Primarily released as organic matter in the "first flush" of urban runoff after storm.
Bacteria	Urban/ Suburban	Avg.-200 to 240,000 MPN/L	High concentrations can lead to aquifer contamination and closure of shellfish harvesting areas and prevent swimming, boating, or other recreational activities.
Zinc	Urban/ Suburban	0.397 mg/l 0.037 mg/l	Chronically exceeds EPA water quality criteria. Many fish species highly sensitive to zinc. Primary cultural source is the weathering and abrasion of galvanized iron and steel.
Copper	Urban/ Suburban	0.105 mg/l 0.047 mg/l (Nationwide Avg.)	Chronically exceeds EPA water quality criteria. Primary cultural source is as a component of anti-fouling paint for boat hulls and in urban runoff, from the leaching and abrasion of copper pipes and brass fittings. An important trace nutrient, it can bioaccumulate, and thereby, create toxic health hazards within the food chain and increase long term ecosystem stress.
Lead	Urban/ Suburban	0.389 mg/l 0.018 mg/l	Lead from gasoline burning in automobiles is less of a problem today because of unleaded gasoline use. However, lead from scraping and painting bridges and overpasses remains. Chronically exceeds EPA water quality criteria. Attaches readily to fine particles that can be bioaccumulated by bacteria and benthic organisms while feeding. Lead has adverse health impacts when consumed by humans.
Oil and Grease	Urban/ Suburban	Avg. 2-10 mg/l	Toxicity contributes to the decline of zooplankton and benthic organisms. Accumulates in the tissues of benthic organisms; a threat to humans when consumed directly or when passed through the food chain. Primary cultural source is automobile oil and lubricants.
Arsenic	Urban/ Suburban	Avg. 6.0 Fg/l	An essential trace nutrient. Can be bioaccumulated; creates toxic health hazards within the food chain and increases long term stress for the ecosystem. Accumulates within tidal, freshwater areas, increasing the toxicity for spawning

			and juvenile fish. Primary cultural source is fossil fuel combustion.
Cadmium	Urban/ Suburban	Avg. 1.0 Fg/l	Primary cultural source is metal electroplating and pigments in paint. Can be bioaccumulated; creates toxic health hazards within the food chain and increases long-term toxic stress for the ecosystem.
Chromium	Urban/ Suburban	Avg. 5.0Fg/l	Primary cultural source is metal electroplating and pigments in paint. Can be bioaccumulated; creates toxic health hazards within the food chain and increases long-term toxic stress for the ecosystem.
Pesticides	Urban/ Suburban	Avg. <0.1 Fg/l	Primary urban source is runoff from home gardens and lawns. Can bioaccumulate in organisms and create toxic health hazards within the food chain. Also has been found as a contaminant in aquifers.

Highway Runoff Constituents and Their Primary Sources

	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer application
Lead	Leaded gasoline (auto exhaust), tire wear (lead oxide filler material, lubricating oil and grease, bearing wear)
Zinc	Tire wear (filler material), motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures (guard rails, bridges, etc.), moving engine parts
Copper	Metal plating, bearing and brush wear, moving engine parts, brake lining wear, fungicides and insecticides
Cadmium	Tire wear (filler material), insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline (exhaust), lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anti-cake compounds (ferric ferrocyanide, sodium ferrocyanide, yellow prussiate of soda) used to keep deicing salt granular
Sodium, Calcium, Chloride	Deicing salts

Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate

Not all urban BMPs can remove both particulate and soluble pollutants. The choice of a particular BMP or series of BMPs depends on many factors. The quantity of storm water, types of pollutants expected, site location (residential, commercial, industrial), site topography, land costs, installation costs, and maintenance requirements will all affect BMP selection.

Several fundamental uncertainties still exist with respect to urban BMPs, including toxicity of residuals trapped by the practice; the interaction of groundwater with BMPs, and the long-term BMP performance.

One BMP that is critical to improving urban storm water quality is public education. Many urban residents are not aware that storm sewers do not carry runoff to treatment plants, but rather directly to nearby rivers. Residents should also understand that while the actions of a single person may seem insignificant, when combined with similar actions of hundreds or thousands of other residents, the potential to pollute their local waters is very real. The quart of oil dumped down a storm drain by one person on a given Saturday may be repeated hundreds of times that day.

Local development plans, ordinances and regulations may also play a role. Plans or regulations may encourage or mandate set backs from water bodies, treatment of runoff from construction sites or impervious areas, or percent allowable impervious area on a given lot size. Zoning requirements may be modified, if necessary, to allow residential development styles that reduce impervious areas and increase green space.

URBAN BMP LIST

(Direct control practices and indirect prevention practices)

The following is a list of the practices for urban BMP. Direct management practices are usually structural practices installed for the purposed of treating contaminated storm water. Indirect management practices are often non-structural methods that focus on pollutant reduction at the source or the use of existing natural features, such as vegetation, to reduce pollutants in stormwater runoff.

Most practices work best with a specific type of pollutant, for example sediments or dissolved metals. When considering a practice or group of practices for a site the decision on what practices to adopt will depend on many factors including the pollutants to be removed, the cost of the practice, site location and size. The information below addresses some common scenarios and list the BMPs that may be most appropriate to that activity.

Direct Management Practices

1. Extended Detention Ponds
2. Wet Ponds
3. Storm Water Wetlands
4. Multiple Pond Systems
5. Infiltration Trenches
6. Infiltration Basins
7. Porous Pavement
8. Concrete Grid Pavement
9. Sand Filters
10. Grassed Swales
11. Filter Strips
12. Sediment Traps
13. Wind Erosion Controls
14. Check Dams - Filter Fence
15. Steep Slope Terraces
16. Water Quality Inlets/Oil Grit Separator
17. Streambank Stabilization – Structural w/ Vegetation
18. Miscellaneous BMPs for Urban Construction

Indirect Management Practices (Reduction/Prevention)

19. Direct Runoff Away From Natural Channels
20. Proper Disposal of Accumulated Sediment
21. Proper Snow Removal and Storage
22. Herbicide/Pesticide/Fertilizer Management
23. Protect Natural Vegetation and Riparian Vegetation
24. Recycling
25. Litter Removal
26. Street Sweeping
27. Exposure Reduction

Locating detention ponds, infiltration basins, infiltration trenches, sand filters, and storm water injection wells within a wellhead protection area is discouraged. Sediment disposal and snow storage are also discouraged in wellhead protection areas.

RUNOFF FROM CONSTRUCTION SITES

INTRODUCTION
Construction contributes pollutants in a number of ways but it primarily increases sediment in surface waters. Vegetation removal on site exposes soils to the elements

increasing erosion. Fuel, oil, and other lubricants from equipment, can contaminate ground water as well as surface waters if carried in runoff.

CONDITIONS
• Residential homesite construction
• Commercial building construction
• Industrial complex construction
• Any type of construction in an urban area
• Recreation facilities
• Parking lot construction

PRACTICES

Direct Management Practices
11. Filter Strips
12. Sediment Traps
13. Wind Erosion Controls
14. Check Dams - Silt Fence
15. Steep Slope Terraces
17. Streambank Stabilization - Structural and Vegetative
18. Miscellaneous BMPs for Urban Construction

Indirect Management Practices (Reduction/Prevention)
19. Direct Runoff Away From Natural Channels
20. Proper Disposal of Accumulated Sediment
21. Proper Snow Removal and Storage
22. Herbicide/pesticide/fertilizer Management
23. Protect Natural Vegetation and Riparian Vegetation
24. Recycling
25. Litter Removal
27. Exposure Reduction

RUNOFF FROM EXISTING DEVELOPMENT

INTRODUCTION
In natural conditions, a high percentage of rainfall infiltrates into the ground. In urban settings, there is a higher percentage of impervious material resulting in a lower rate of infiltration. Impervious materials, such as pavement, rapidly channel runoff to a storm sewer conveyance. Storm sewers normally discharge directly into surface waters. Runoff entering these waters is normally untreated and carries a heavy pollutant load. Sediments, oils, fertilizers, and metals are the primary pollutants.

CONDITIONS
• Residential Neighborhoods
• Office Complexes

- Airports
- Commercial Districts
- Driveways and Sidewalks
- Rooftops
- Parking Lots and Structures
- Industrial Complexes

PRACTICES

Direct Management Practices
1. Extended Detention Ponds
5. Infiltration Trenches
6. Infiltration Basins
7. Porous Pavement
8. Concrete Grid Pavement
9. Sand Filters
10. Grassed Swales
11. Filter Strips
12. Sediment Traps
13. Wind Erosion Controls
14. Check Dams - Filter Fence
15. Steep Slope Terraces
16. Water Quality Inlets/Oil Grit Separator
17. Streambank Stabilization - Structural and Vegetative

Indirect Management Practices (Reduction/Prevention)
19. Direct Runoff Away From Natural Channels
20. Proper Disposal of Accumulated Sediment
21. Proper Snow Removal and Storage
22. Herbicide/Pesticide/Fertilizer Management
23. Protect Natural Vegetation and Riparian Vegetation
24. Recycling
25. Litter Removal
26. Street Sweeping
27. Exposure Reduction

RUNOFF FROM DEVELOPING AREAS

INTRODUCTION
These are areas that have the potential for increased development in the immediate future. In these situations there is the potential to consider problems, sources of pollution, and future needs. This allows urban planners to incorporate solutions before and during development. As one moves towards the fringes of urban areas, there may be state or municipal regulations to mitigate potential pollution to surface and ground water. An

example is the introduction of green space to protect surface water riparian areas. Incorporating pollution prevention into development plans is generally simpler and more cost-effective than attempting to retrofit BMPs into existing sites.

CONDITIONS
• Subdivision Developments
• Office Park Development
• Mall Construction
• Gas Stations
• Recreation Facilities

PRACTICES
Direct Management Practices
1. Extended Detention Ponds
2. Wet ponds
3. Storm water Wetlands
4. Multiple Pond Systems
6. Infiltration Basins
7. Porous Pavement
8. Concrete Grid Pavement
9. Sand Filters
10. Grassed Swales
11. Filter Strips
12. Sediment Traps
13. Wind Erosion Controls
14. Check Dams - Filter Fence
15. Steep Slope Terraces
17. Streambank Stabilization - Structural and Vegetative
18. Miscellaneous BMPs for Urban Construction

Indirect Management Practices (Reduction/Prevention)
19. Direct Runoff Away From Natural Channels
20. Proper Disposal of Accumulated Sediment
21. Proper Snow Removal and Storage
22. Herbicide/Pesticide/Fertilizer Management
23. Protect Natural Vegetation and Riparian Vegetation
24. Recycling
25. Litter Removal
27. Exposure Reduction

GENERAL SOURCES (HOUSEHOLD, COMMERCIAL, AND LANDSCAPING)

INTRODUCTION

Each household in itself may not be a problem, but the combined cumulative effect of cleaning products, pesticides and fertilizers can be a significant pollution problem. Contamination may result from such practices as improper waste disposal or improper application of fertilizers. This can lead to eutrophication or over nitrification of streams, lakes and wetlands. The streams receiving contaminated storm water may double as a drinking water source.

CONDITIONS
• Residential Landscaping
• Office and Business Activities
• Commercial Landscapers
• Storage Buildings
• Auto Services
• Golf Courses
• Household Product Use and Disposal

PRACTICES

Direct Management Practices
2. Wet ponds
3. Storm water Wetlands
4. Multiple Pond Systems
5. Infiltration Trenches
7. Porous Pavement
8. Concrete Grid Pavement
9. Sand Filters
10. Grassed Swales
11. Filter Strips
13. Wind Erosion Controls
15. Steep Slope Terraces
17. Streambank Stabilization - Structural and Vegetative

Indirect Management Practices (Reduction/Prevention)
19. Direct Runoff Away From Natural Channels
21. Proper Snow Removal and Storage
22. Herbicide/Pesticide/Fertilizer Management
23. Protect Natural Vegetation and Riparian Vegetation
24. Recycling
25. Litter Removal
27. Exposure Reduction

RECYCLING

Environmental Problem

Improper waste management can increase pollutant loadings in runoff to surface waters and leaching to ground waters. Improper management of household hazardous wastes typically occurs due to unawareness of proper disposal methods or lack of disposal alternatives.

Management Options

Onsite management of yard wastes by homeowners who compost lawn and yard wastes such as leaves, grass clippings and woody wastes. Many municipalities and counties offer **composting facilities** to residents at little or no charge. Composting reduces landfill volumes and the need for fertilizer by increasing soil nutrients and organic matter.

Developing a convenient, low-cost **household hazardous waste collection** program encourages proper disposal of potential pollutants. Products typically collected by these programs are used oil and antifreeze, unwanted paint and unneeded household chemicals (cleaners, pesticides, herbicides, etc.). Some jurisdictions offer free **product exchange** programs where homeowners who drop off unneeded, potentially hazardous materials may also pick up other products that may be useful to them.

Promote pollution prevention as a means of waste reduction within business and government. Pollution prevention includes recycling as a means of waste reduction, but also includes strategies to reduce use of hazardous materials such as product substitution. For many businesses recycling also cuts expenses as input materials are reused or converted to new uses within the same business or as a product for another business.

LITTER REMOVAL

Environmental Problem

Litter enters surface waters via wind and runoff events. Litter and yard wastes can clog storm water control and conveyance structures making the devices ineffective in storm water pollutant control. Contaminants such as plastics and Styrofoam degrade slowly, while presenting environmental risks to fish and wildlife. Pet feces (from dogs, cats, horses, etc.) can contribute fecal coliform bacteria to surface waters. Fecal coliforms are a potential human health hazard for drinking water supplies and contact recreation, such as fishing or swimming.

Management Options

Promote litter removal programs such as Adopt-a-Highway and city/park/river clean-up days within the community. Encourage local pride within the community through civic organizations to promote individual actions affecting litter removal.

Municipal facilities maintenance programs and commercial and industrial storm water permittees should regularly clean inlets, catch basins, outlets and any other necessary areas within stormwater conveyance and collection areas.

Encourage residents to “scoop the poop” when they walk their pets. Some parks in larger cities provide bags for dog walkers. Animals, such as horses, cows, etc., should be watered away from streams, ponds or lakes to prevent direct entry of fecal material.

STREET SWEEPING

Environmental Problem

Particles accumulate along streets and in parking lots that are washed into surface waters by storm events.

Management Options

Mechanical broom sweepers are effective at removal of curbside litter and street particles greater than 400 micro m in size. Vacuum sweepers are more effective on small particles, but can not be used on wet streets. Removing smaller particles helps to reduce transport of sediment-bound pollutants. In areas such as downtown business districts sweepers may be one of the few options for particle removal.

Disposal of street sweeping waste may pose a problem because of possible high levels of lead, zinc, copper and other wastes from automobile traffic. Testing of sweepings may be appropriate to determine disposal alternatives. Some municipalities and industries have found that street sweepings can be used as cover in sanitary landfills.

EXPOSURE REDUCTION

Environmental Problem

Runoff that directly contacts stored materials or inventory can transport pollutants to surface or ground water.

Management Options

Industries, municipalities and homeowners can reduce pollution by reducing or **eliminating exposure** by simply moving materials indoors or removing materials, products, devices and outdoor manufacturing activities that may contribute pollution to runoff. Particularly, removal of rarely used materials that are stored outdoors can be simple and effective.

An **inventory** of the items on municipal, commercial and industrial sites that are exposed to rain may provide a useful starting point for exposure-reduction activities. Examples are raw material stockpiles, stored finished products, and machinery or engines which leak fuel or oil.

The partial or total **covering** of stockpiled or stored material loading/unloading areas, or processing operations, waste storage areas will reduce or eliminate potential pollutants in runoff. For sites that are only partially covered directing storm water "run-on" away from materials will also reduce pollutant loading in storm water.

Changes in **inventory management** to a "just-in-time" (JIT) method will reduce the amount of materials exposed to storm water at any given time. JIT uses precise scheduling of materials and products in and out of a site to keep the amount of raw materials and products on hand to a minimum, reducing waste, storage costs and potential pollutants exposed to storm water.

Good housekeeping involves maintaining equipment to be free of leaks, removing empty materials containers, removing trash, sweeping of parking lots and roads, disposal of unused equipment. All these activities reduce exposure of pollutants to storm water.

Training and prevention programs prepare employees to prevent spills and to respond quickly when spills do occur.

EDUCATION

Much of urban nonpoint source pollution is the result of cumulative actions by many individuals, businesses and industries. The reduction of NPS pollution, in turn, depends on the choices and actions of individuals, businesses, and industries. Often individuals and business owners are not aware that storm drains deliver runoff to nearby waterbodies without treatment. Nor are many aware that some of their common practices (over-fertilization, material storage, etc.) may contribute to pollution. Community education is one of the most effective ways of preventing storm water pollution.

Businesses, developers, and homeowners are all part of the NPS pollution puzzle and public awareness programs must be tailored to meet the individual needs and interests of each segment of the community. For example, programs for homeowners might focus on the use of lawn chemicals and disposal of common household wastes such as motor oil, cleaners, and herbicides. Business-oriented programs might stress good housekeeping and chemical reuse strategies. Any education program should provide not only concrete information about pollutant sources and causes, but also specific information about storing, using, and disposing of materials which may cause storm water pollution.

Involve community groups when possible. School or youth groups may be interested in stenciling storm drains with a message such as, "Dump No Waste; Drains to River."

Educational materials or presentations can be made available at a variety of community forums such as fairs, Earth Day events, town meetings, service organizations, and local festivals. "Adopt-a-River" type programs may be adapted to include educational efforts on the effects of pollution in storm water runoff.

Storm drain stenciling marker found at a new subdivision adjacent to Bayou Chauvin off of Woodland Drive

Information on storm water best management practices and educational materials are available from many sources. Federal, state and many local governments may have written material or information on internet web pages. Many private organizations are also involved in improving urban water quality and public education. Louisiana Department of Environmental Quality also has water-quality grants available annually for demonstration or assessments projects and educational programs. Depending on the source of the grants they may be awarded to state or local government units, schools, non-governmental organizations (clubs, conservation groups, *et cetera*) or individuals. Demonstration and assessment types of projects must have an educational component. For more information on grant availability and requirements, contact the Nonpoint Source Program Coordinator at the Louisiana Department of Environmental Quality, Water Quality Assessment Division, 225-219-3595.

6.3 Home Sewage BMPs

The 2006 303(d) list identified sanitary sewer overflow as a leading source of impairment to fish and wildlife propagation in the Bayou Chauvin watershed. Wastewater contains several undesirable pollutants. Pathogens, which can be in the form of bacteria, viruses, or mold spores, are disease-causing agents that are normally present in large numbers in sewage wastes. Pathogens can enter drinking water supplies creating a potential health hazard. Nutrients and organic matter entering waterways can lead to tremendous growth in the quantity of aquatic microorganisms. Metabolic activity of these microbes can reduce oxygen levels in the water causing aquatic life to suffocate. Failing home septic systems have the potential to cause significant problems in the watershed by contributing nutrients, organic matter and fecal coliform bacteria. Prevention practices include proper installation, location, size, and operation maintenance. Septic systems should not be installed without obtaining the proper permits from the State Health Officer. In addition, sewer systems should be inspected and pumped out every 3-5 years by a licensed professional.

Prevention:

If a home is located in an area subject to periodic flooding such as in a floodplain or where sewage backups have occurred, the homeowner should implement "all feasible measures" to prevent/minimize the nature and extent of impacts from such situations. Such actions can be preventive or pro-active.

Preventive actions include:

1. Waterproofing the building foundation and/or sealing cracks in foundation floor or walls; and
2. Installing a check valve or shut-off valve on the building sewer close to where it enters the structure. This will protect your home from sewage back-ups due to surcharging conditions in the municipal sewerage system.

Pro-active measures include:

1. Purchasing or installing a pump (e.g. sump pump) to pump out water that collects in the low point of the structure;
2. Ensure that building gutter downspouts and drains are directed away from the foundation and toward low points away from the home; and
3. If minor flooding occurs, follow the water to its point-of-entry and seal cracks or defects to the extent possible.

Remember, an ounce of prevention is worth more than a pound of cure. Flood insurance is also vitally important where properties are known to be in floodplains or flood prone areas. More information on prevention and flood insurance is available on the FEMA website.

Potential problems

1. Excessive dumping of cooking oils and grease can fill up the upper portion of the septic tank and can cause the inlet drains to block. Oils and grease are often difficult to degrade and can cause odor problems and difficulties with the periodic emptying.
2. Flushing non-biodegradable hygiene products such as sanitary towels and cotton buds will rapidly fill or clog a septic tank; these materials should not be disposed of in this way.
3. The use of waste macerators or grinders for disposal of waste food can cause a rapid overload of the system and early failure.
4. Certain chemicals may damage the working of a septic tank, especially pesticides, herbicides, materials with high concentrations of bleach or caustic soda (lye) or any other inorganic materials such as paints or solvents.
5. Roots from trees and shrubbery growing above the tank or the drain field may clog and or rupture them.
6. Playgrounds and storage buildings may cause damage to a tank and the drainage field. In addition, covering the drainage field with an impervious surface, such as a driveway or parking area, will seriously affect its efficiency and possibly damage the tank and absorption system.
7. Excessive water entering the system will overload it and cause it to fail. Checking for plumbing leaks and practicing water conservation will help the system's operation.
8. Even well maintained septic tanks release mucus-producing anaerobic gut bacteria to the drainage field. The mucus "slime" will slowly clog the soil pores surrounding the drain pipe and percolation can slow to the point where backups or surfacing effluent can occur. This slime is called biomat and such a failure is referred to as "Biomat failure".
9. If the system is damaged or malfunctions, contact your local health or environmental authority before attempting any repairs. Improper repair can result in costly mistakes and potential health hazards.

10. Septic tanks by themselves are ineffective at removing nitrogen compounds that can cause algae blooms in receiving waters; this can be remedied by using a nitrogen-reducing technology.[1

Caring for a Septic System

(Conventional Septic System, Innovative/Alternative (I/A) System, or Cesspool)

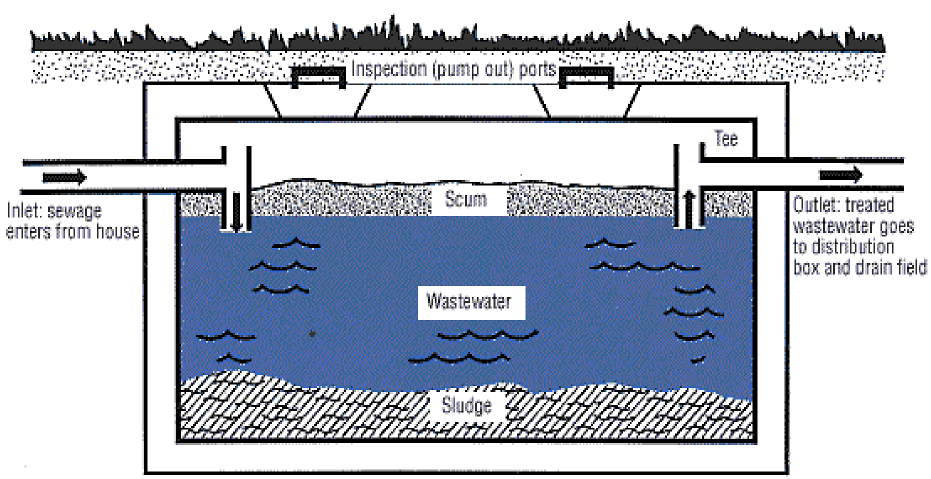
The accumulated solids in the bottom of the septic tank should be pumped out *every three years* to prolong the life of your system. Septic systems must be maintained regularly to stay working.

Neglect or abuse of your system can cause it to fail. Failing systems can

- cause a serious health threat to your family and neighbors,
- degrade the environment, especially lakes, streams and groundwater,
- reduce the value of your property,
- be very expensive to repair, and
- put thousand of water supply users at risk if you live in a public water supply watershed and fail to maintain your system.

Be alert to these warning signs of a failing system:

- sewage surfacing over the drainfield (especially after storms),
- sewage back-ups in the house,
- lush, green growth over the drainfield,
- slow draining toilets or drains,
- sewage odors.



Tips to Avoid Trouble

DO have your tank pumped out and system inspected every 3 to 5 years by a licensed septic contractor (listed in the yellow pages).

DO keep a record of pumping, inspections, and other maintenance. Use the back page of this brochure to record maintenance dates.

DO practice water conservation. Repair dripping faucets and leaking toilets, run washing machines and dishwashers only when full, avoid long showers, and use water-saving features in faucets, shower heads and toilets.

DO learn the location of your septic system and drainfield. Keep a sketch of it handy for service visits. If your system has a flow diversion valve, learn its location, and turn it once a year. Flow diverters can add many years to the life of your system.

DO divert roof drains and surface water from driveways and hillsides away from the septic system. Keep sump pumps and house footing drains away from the septic system as well.

DO take leftover hazardous household chemicals to your approved hazardous waste collection center for disposal. Use bleach, disinfectants, and drain and toilet bowl cleaners sparingly and in accordance with product labels.

DON'T allow anyone to drive or park over any part of the system. The area over the drainfield should be left undisturbed with only a mowed grass cover. Roots from nearby trees or shrubs may clog and damage your drain lines.

DON'T make or allow repairs to your septic system without obtaining the required health department permit. Use professional licensed contractors when needed.

DON'T use commercial septic tank additives. These products usually do not help and some may hurt your system in the long run.

DON'T use your toilet as a trash can by dumping nondegradables down your toilet or drains. Also, don't poison your septic system and the groundwater by pouring harmful chemicals down the drain. They can kill the beneficial bacteria that treat your wastewater. Keep the following materials out of your system:

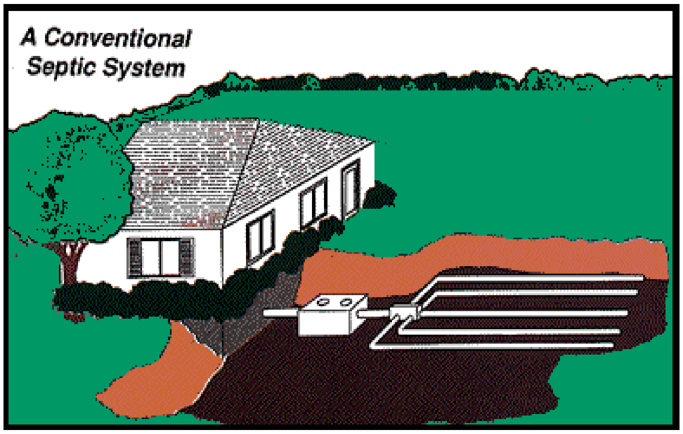
NONDEGRADABLES: Grease, disposable diapers, plastics, etc.

POISONS: Gasoline, oil, paint, paint thinner, pesticides, antifreeze, etc.

Septic System Explained

Septic systems are individual wastewater treatment systems (conventional septic systems, innovative/alternative (I/A) systems, or cesspools) that use the soil to treat small wastewater flows, usually from individual homes. They are typically used in rural or large lot settings where centralized wastewater treatment is impractical.

There are many types of septic systems in use today. While all systems are individually designed for each site, most systems are based on the same principles.



A Conventional Septic System

A conventional septic system consists of a septic tank, a distribution box and a drainfield, all connected by pipes, and called conveyance lines.

A septic system treats household wastewater by temporarily holding it in the septic tank where heavy solids and lighter scum are allowed to separate from the wastewater. This separation process is known as primary treatment. The solids stored in the tank are decomposed by bacteria and later removed, along with the lighter scum, by a professional septic tank pumper.

After partially treated wastewater leaves the tank, it flows into a distribution box, which separates this flow evenly into a network of drainfield trenches. Drainage holes at the bottom of each line allow the wastewater to drain into gravel trenches for temporary storage. This effluent then slowly seeps into the subsurface soil where it is further treated and purified (secondary treatment). A properly functioning septic system does not pollute the groundwater.

7.0 MAKING THE IMPLEMENTATION PLAN WORK

In order to reduce the NPS load in Bayou Chauvin watershed in Subsegment 120507, to meets its designated uses and is no longer listed on the 303(d) list, BMP's and/or other conservation practices will need to be implemented. This will require programs that provide technical assistance, funding, incentives, as well as foster a sense of stewardship.

Many of these programs that are designed to assist the landowner are already in place. The LDEQ's Nonpoint Source Unit provides monies distributed through the USEPA under Section 319 of the CWA. These funds are utilized to implement BMPs for all types of land uses within the watershed in order to reduce and/or prevent the NPS pollutants and achieve the bayou's designated uses. The USDA and NRCS are federal government agencies that have several such programs made available by way of the Farm Security and Rural Investment Act of 2002. These programs are made available through the local Soil and Conservation District (SWCD). The NRCS has a list of BMPs for almost all types of programs to facilitate their use.

Parish-wide cooperation and coordination will be necessary in order to protect water quality within the Bayou Chauvin watershed. Though challenging, it is an opportunity for leaders, officials, and local citizens to come together for a common interest. As a result, people develop new relationships which will benefit the community and their watershed. The watershed approach helps build new levels of cooperation and coordination, which is necessary to successfully control NPS loading and thus restore and protect Bayou Chauvin.

Every stakeholder within a watershed partnership brings important information, viewpoints, and ideas to the group. Local citizens have a good idea of problems within their watershed. They are able to provide input when practical solutions are developed. Much of the valuable historical information essential to watershed planning, concerning past land use and associated problems, can be provided by local citizens. Environmental scientists, biologists, engineers, and resource managers can provide their technical expertise as well. The partnership works together to prioritize problem areas and develop viable solutions. The water body itself helps promote cooperation among stakeholders in the watershed partnership because most people want to protect and restore their natural resources for future generations. The locally based watershed partnership provides an avenue for stakeholders to communicate with each other, share resources, work on common goals, and assist in bringing funding into the area for special projects, BMP cost-share programs, and overall education.

7.1 Regulatory Authority

Section 319 of the Clean Water Act (PL 100-4, February 4, 1987) was enacted to specifically address problems attributed to nonpoint sources of pollution. Its objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (Sec. 101; PL 100-4). Section 319 directs the governor of each state to prepare and submit a nonpoint source management program for reduction and control of pollution from nonpoint sources to navigable waters within the state by implementation of a four-year plan, submitted within 18 months of the day of enactment (LDEQ, 2000).

In response to the federal law, the State of Louisiana passed the Revised Statute 30:2011, which had been signed by the Governor in 1987, as Act 272. Act 272 designated the Louisiana Department of Environmental Quality (LDEQ) as the Lead Agency to develop and implement of the State's Nonpoint Source Management Plan. LDEQ's Office of

Water Resources (OWR) was charged with the responsibility to protect and preserve the quality of waters in the State and has developed the nonpoint source management program, ground water quality program and a conservation and management plan for estuaries. These programs and plan were developed in coordination with the appropriate state agencies such as the Department of Natural Resources, Department of Wildlife and Fisheries, Department of Agriculture and Forestry and the State Soil and Water Conservation Committees in various jurisdictions (La.R.S. 30:20). LDEQ's Office of Water Resources is therefore responsible for receiving federal funds to ensure clean water, providing matching state funds when required and complying with terms and conditions necessary to receive federal grants.

The water quality standards are described in LAC 33:IX.1101.D in chapter 11 (LDEQ, 2003). These standards are applicable to surface waters of the state and are utilized through the waste load allocation and permit process to develop effluent limitations for point source discharges to surface waters of the state. The water quality standards also form the basis for implementing the best management practices for control of nonpoint sources of water pollution.

Chapter 11 also describes the anti-degradation policy (LAC 33:IX.1109.A.2) which states that the administrative authority will not approve any wastewater discharge or certify any activity for federal permit that would impair water quality or use of state waters. Waste discharges must comply with applicable state and federal laws for the attainment of water quality goals. Any new, existing, or expanded point source or nonpoint source discharging into state waters, including land clearing, which is the subject of a federal permit application, will be required to provide the necessary level of waste treatment to protect state waters as determined by the administrative authority. Further, the highest statutory and regulatory requirements shall be achieved for all existing point sources and best management practices (BMPs) for nonpoint sources. Additionally, no degradation shall be allowed in high-quality waters that constitute outstanding natural resources, such as waters of ecological significance as designated by the office. Those waterbodies presently designated as outstanding resources are listed in LAC 33:IX.1123.

7.2 Actions Being Implemented by LDEQ

LDEQ is presently designated as the lead agency for implementation of the Louisiana Nonpoint Source Program. LDEQ Nonpoint Source Unit provides USEPA §319(h) funds to assist in implementation of BMPs and to address water quality problems on subsegments listed on the §303(d) list or those subsegments which are located within Category I Watersheds as identified under the Unified Watershed Assessment of the Clean Water Action Plan. USEPA §319(h) funds are utilized to sponsor cost sharing, monitoring, and education projects. These monies are available to all private, for profit, and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, federal agencies, or agencies of the State. Presently, LDEQ is cooperating with such entities on nonpoint source projects which are active throughout the state.

An example of a LDEQ 319 project was recently completed, in the Terrebonne Basin, entitled "Urban BMP Training and Education and Home Sewerage Education Awareness." The goal of this project was to implement an educational program along with an accompanying video, as well as to install construction BMPs at a new South Central Planning Development Commission building site. Additionally, an educational awareness program was developed to help inform local citizens and parish officials on sewerage pollution problems.

In addition, LDEQ currently has on file an active Municipal Separate Storm Sewer System (MS4) Discharge Permit for Terrebonne Parish (LAR041023). The permit has just been renewed with effect dates of December 5, 2007 through December 4, 2012. The permit authorizes the discharge of stormwater from the regulated areas covered by the Terrebonne Parish Consolidated Government Small MS4. The permitted areas include:

- Terrebonne Parish Small MS4,
- City of Bayou Cane Small MS4,
- Town of Chauvin Small MS4,
- Town of Gray Small MS4,
- City of Houma Small MS4,
- Town of Montegut Small MS4, and
- City of Schriever Small MS4.

All of these are located within the 2000 U.S. Census-designated Houma Urbanized Area.

7.3 Actions Being Implemented by other Agencies

The U.S. Department of Agriculture (USDA) and Natural Resource Conservation Service (NRCS) offers landowners financial, technical, and educational assistance to implement conservation practices and/or BMPs on privately owned land to reduce soil erosion, improve water quality, and enhance crop land, forest land, wetlands, grazing lands and wildlife habitat. The new "Farm Security and Rural Investment Act of 2002", known as the 2002 Farm Bill provides funding to various conservation programs for each state by way of the NRCS and the State's local Soil and Water Conservation Districts (SWCD). Although most of these programs are designed to assist agriculture, there may be cases where the 2002 Farm Bill may be utilized for conservation practices for other land uses. A complete list of agriculture BMPs is provided by the NRCS in their "Field Office Technical Guide Handbook". The handbook includes a description of each BMP and their recommended uses. Each BMP is listed by a code, i.e. Field Border (386). The following includes a brief summary of the programs available through the local SWCD under the oversight of USDA and NRCS. The descriptions of the programs are general and based on information available at that time; key points subject to change as rules established:

Agricultural Management Assistance Program

This program provides cost share assistance to agricultural producers who will voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Such practices might include constructing an irrigation structure, planting trees to improve water quality, or resource conservation practices such as soil erosion control.

Environmental Quality Incentives Program (EQIP)

EQIP was reauthorized in the 2002 Farm Bill to provide a voluntary conservation program for farmers or ranchers that promote agricultural production and environmental quality as compatible goals. This program offers financial and technical assistance to eligible participants in developing management practices on their agricultural land.

Conservation Reserve Programs (CRP)

The 1985 Farm Bill established CRP as a voluntary program to protect highly erodible and environmentally sensitive lands. CRP provides technical and financial assistance to eligible farmers and ranchers (on a voluntary basis) to addresses soil, water and related natural resource concerns to protect highly erodible and environmentally sensitive lands.

Watershed Operations

Watershed Operations is a voluntary program under the authority of the Watershed Protection and Flood Prevention Act of 1054 (P.L. 83-566 and by the Flood Control Act of 1944 (P.L. 78-534). Under this program, the NRCS provides technical and financial assistance to states, local governments and tribes to implement authorized watershed project plans for the purpose of watershed protection, flood mitigation, soil erosion reduction, irrigation water management, sediment control, fish and wildlife enhancement and wetlands creation and restoration.

Rapid Watershed Assessments

NRCS is encouraging the development of rapid watershed assessments in order to increase the speed and efficiency to guide conservation implementation. In a nut shell, this program will provide quick and inexpensive plans for setting priorities in a watershed and taking action.

Wetlands Reserve Program (WRP)

This voluntary program provides technical and financial assistance from the NRCS to help landowners in protecting, restoring and enhancing wetlands on their property. The goal of this program is to achieve the greatest wetland functions and values along with optimum wildlife habitat on all wetlands enrolled in the program.

Wildlife Habitat Incentives Program (WHIP)

WHIP is a voluntary program for those interested in developing and improving wildlife habitat primarily on private land. Technical assistance and up to 75% cost share assistance is provided in order to establish and improve fish and wildlife habitat. A WHIP agreement between NRCS and the participant generally last from 5 to 10 years.

Conservation Security Program (CSP)

CSP is a new national incentive payment program for maintaining and increasing farm and ranch stewardship practices. The CSP is designed to correct a policy disincentive in which independently conducted resource stewardship has disqualified many farmers from receiving conservation program assistance. Features an optional "tiered" level of farmer participation where higher tiers receive greater funding for greater conservation practices.

Master Farmer Program

The Louisiana State University Agricultural Center developed the Master Farmer Program. This voluntary program is based on educating farmers about environmental stewardship, resource based production and resource management. Becoming a certified Master Farmer involves classroom instruction on water quality regulations, conservation practices, crop specific best management practices and implementation, and USDA conservation funding. Participants will visit model farms to view the implementation of best management practices in reducing sediment runoff. Finally, a farm specific conservation plan will be developed. Becoming a "master farmer" can set an example for the agricultural community to become involved in implementing best management practices and in helping to control nonpoint source pollution. Economically and effective best management practices can make a huge impact on reducing the agriculture's contribution to the water quality problems in the Bayou Chauvin Watershed.

Barataria-Terrebonne National Estuary Program

The Barataria-Terrebonne National Estuary Program's (BTNEP) main goals are to help prevent activities that threaten an estuary's public water supply, are harmful to fish, shellfish, and wildlife populations, and negatively impact recreational opportunities for estuary residents. BTNEP's challenge is to coordinate all agency and stakeholder efforts related to restoration in the Barataria – Terrebonne estuary system to create a sense of environmental stewardship for the natural resources of the estuary complex. BTNEP's water quality action plans to reduce NPS pollution include a reduction of agricultural pollution and stormwater management. The plan proposes to reduce agricultural components by applying BMPs. The results are improved water quality and estuarine ecosystem health. LDEQ's monitoring program provides data as to the success of the implemented action plan. Long term success in the implementation of BMPs will be seen in the reduction of urban NPS pollutants and a reduction in the number of water subsegments not meeting water quality criteria due to urban runoff. The plan promotes the use of alternative methods for the disposal of storm waters. Storm water management will be accomplished by performing studies that will increase the knowledge base of alternative stormwater disposal. The focuses of these programs are:

- To reduce loadings of nutrients, fecal coliform bacteria, and pollutants to water bodies,
- To improve water quality in support of enhanced natural resources, and
- To enhance wetland vegetation.

BTNEP will soon be partnering with LDEQ on the 319 Clean Waters Program. The agencies will work together, through this program, to identify nonpoint source relative contributions to watersheds, develop contacts with watershed stakeholder groups, establish watershed committees which will assist in the development of watershed plans on impaired water bodies, review ambient data and development educational material for middle school and high schools and outreach material for laypersons to promote environmental awareness and activities that are protective and enhancing of area surface waters. (www.btnep.org).

In addition to the programs mentioned, the following organizations have signed a Memorandum of Understanding (MOU) with LDEQ within the state's NPS Management Plan that each will aid LDEQ in achieving the goals of the management plan:

- Louisiana Department of Agriculture and Forestry
- Louisiana Department of Health and Hospitals
- Louisiana Department of Wildlife and Fisheries
- Louisiana Department of Transportation and Development
- Louisiana Department of Natural Resources
- Louisiana State University Agricultural Center
- Natural Resources Conservation Service
- USDA – Farm Services Agency
- Louisiana Forestry Association
- US Fish and Wildlife Service
- USDA Forest Service
- US Army Corps of Engineers
- US Geological Survey
- Federal Emergency Management Agency
- Louisiana Farm Bureau Federation

7.4 Implementation and Maintenance

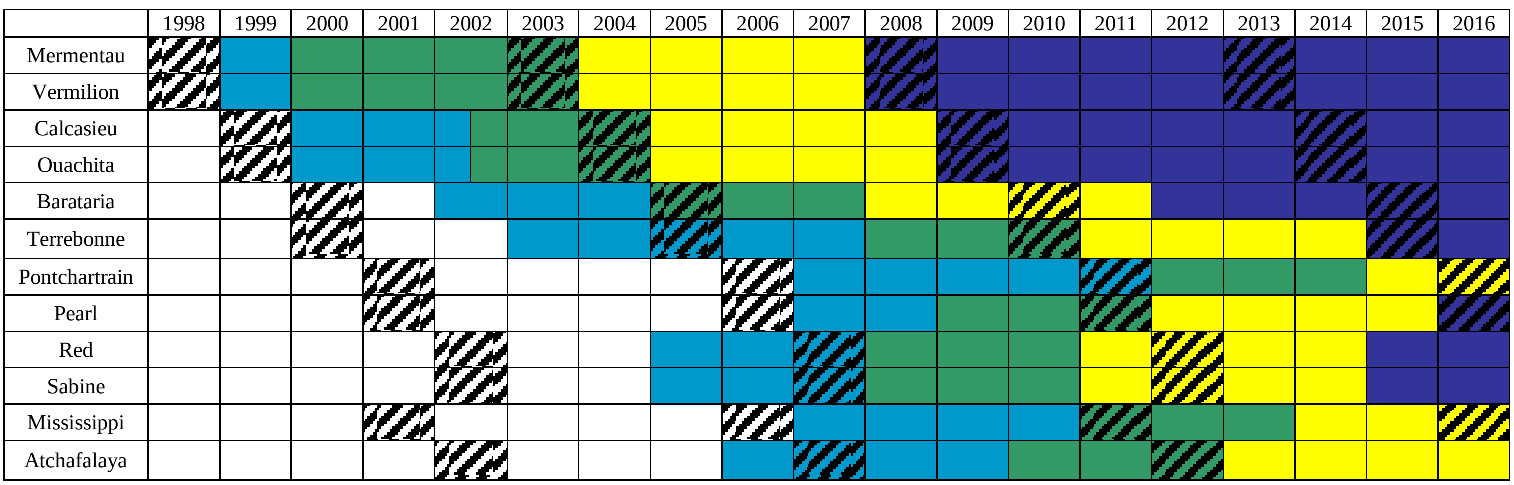
Citizens, commercial businesses, and even local and state agencies can implement and maintain efficient BMPs by taking the conservative approach to many everyday landscaping events. For example, fertilizing and sufficiently seeding grass to promote long-term stabilization of soil surfaces and planting wildflower cover (a practice used by many highway departments to provide aesthetically pleasing vegetation along roadways) greatly reduces the potential for erosion by securing the surfaces with plant roots. Other practices such as sodding and mulching can also be applied and have similar effective results.

Implementing change is the key to adopting best management practices and improving water quality. The implementation of management measures, best management practices and conservation practices to reduce nonpoint source pollution in the Bayou Chauvin Watershed will require the cooperation of citizens, stakeholders and local governments. Programs are available to provide technical assistance, funding, and incentives. The USDA and the NRCS are federal government agencies that have several programs made available by way of the Farm Security and Rural Investment Act of 2002. These programs are made available through the local Soil and Water Conservation Districts (SWCD).

Public participation and voluntary action in Bayou Chauvin are vital to the protection of the watershed. Citizens need to be informed of the objectives for implementing BMPs and how they work to benefit the community and themselves. A public education program can greatly improve the feasibility of implementing BMPs to protect water quality. Informed citizens can be helpful in supporting and assisting monitoring and enforcement programs.

8.0 TIMELINE FOR IMPLEMENTATION

The NPS Implementation Plan for the Bayou Chauvin Watershed in Subsegment 120507 outlines a 4-year management plan to reduce NPS pollutants reaching the waterway. LDEQ intensively samples each watershed in the state once every 4 years to see if the waterbodies are meeting water quality standards. Prior to 2004, waterbodies were sampled once every 5 years. Therefore, sampling began during 2000 for the Terrebonne Basin, including Bayou Chauvin, occurred again in 2005. Sampling will also occur in 2009 and in 2013 (Table 8). The data from 2005 will be used as a baseline to measure the rate of water quality improvement in samples taken in subsequent years. If no improvement in water quality is witnessed by the 2009 sampling, LDEQ will revise the NPS Implementation Plan to include additional corrective actions to bring the waterway into compliance. Additional BMPs and or other options will be employed, if necessary, until water quality standards are achieved and Bayou Chauvin is restored to its designated uses.



1. Black Stripes = Collect Water Quality Data to Develop Total Maximum Daily Loads (TMDLs) and to Track Water Quality Improvement at the Watershed Level [Objective 1]
2. Light Blue = Develop Total Maximum Daily Loads for the Watersheds on the 303(d) List [Objective 2]
3. Green = Develop Watershed Management Plans to Implement the NPS Component of the TMDL [Objective 3]
4. Yellow = Implement the Watershed Management Plans [Objectives 4-8]
5. Dark Blue = Develop and Implement Additional Corrective Actions Necessary to Restore the Designated Uses to the Water Bodies [Objective 9-10]

8.1 Tracking and Evaluation

As stated in the Louisiana Nonpoint Management Plan, program tracking will be done at several levels to determine if the watershed approach is an effective tool to reduce nonpoint source pollution and improve water quality. The following actions will be taken to determine the effectiveness of this approach:

1. Tracking of management measures outlined within the Watershed Restoration Action Strategy (short-term)
2. Tracking of BMPs implemented as a result of Section 319 Program, EQIP, or other sources of cost-share and technical assistance within the watershed (short term);
3. Tracking progresses in reducing nonpoint source pollutants, such as solids, nutrients, and organic carbon from the various land uses (rice, soybeans, crawfish farms) within the watershed (short-term);
4. Tracking water quality improvement in the bayou (i.e. decreases in total organic carbon, total dissolved oxygen) (short and long term)
5. Documenting results of the tracking to the Nonpoint Source Interagency Committee, residents within the watershed, and EPA (short and long term);
6. Submitting semi-annual and annual reports to EPA which summarize results of the watershed restoration action strategies (short and long term); and
7. Revising LDEQ’s web-site to include information on the progress made in the watershed restoration actions, nonpoint source pollutant load reductions, and water quality improvement in the bayou (short and long term).

9.0 SUMMARY OF THE WATERSHED IMPLEMENTATION PLAN

In order to restore its water uses for Bayou Chauvin watershed in Subsegment 120507, it requires a concerted effort from all stakeholders, including federal, state, and local government, private and public groups, and most importantly, the communities and local citizens. A person who lives in the watershed is a stakeholder and stands to benefit from their contribution toward protecting the waters. The fundamental value of outreach/social marketing efforts is to increase essential environmental understanding, build watershed constituencies, and provide key support for an array of other environmental protection strategies. As part of natural resource protection, local cities, other agencies, and non government organizations are encourage to conduct public education and outreach activities to promote stewardship, water quality, recycling, and general sustainability.

Public education and outreach strategies are the key element for achieving the goal and objective of improving water quality in the Bayou Chauvin watershed, and are a necessary tool to promote the understanding and the support efforts to implement BMPs.

The educational component may accelerate a greater concern for the environment, and thereby encourage the communities to take action without additional environmental regulations imposed on the communities. Awareness of these problems is needed along with education about the various Best Management Practices (BMPs) for business owners and homeowners in general. More information on Nonpoint Source Pollution (NPS) can be found at LDEQ's NPS website at http://nonpoint.deq.louisiana.gov. Successful outcomes are more likely when citizens understand what is occurring and why. When stakeholders volunteer to demonstrate conservation practices on their lands they should receive positive recognition and other incentives; therefore, positively reinforcing others to do the same.

Achieving a clean water goal without inhibiting the developments in the Bayou Chauvin watershed would require all the stakeholders an ownership of the watershed. The educational component of the NPS program can be a major tool to achieving water quality objective.

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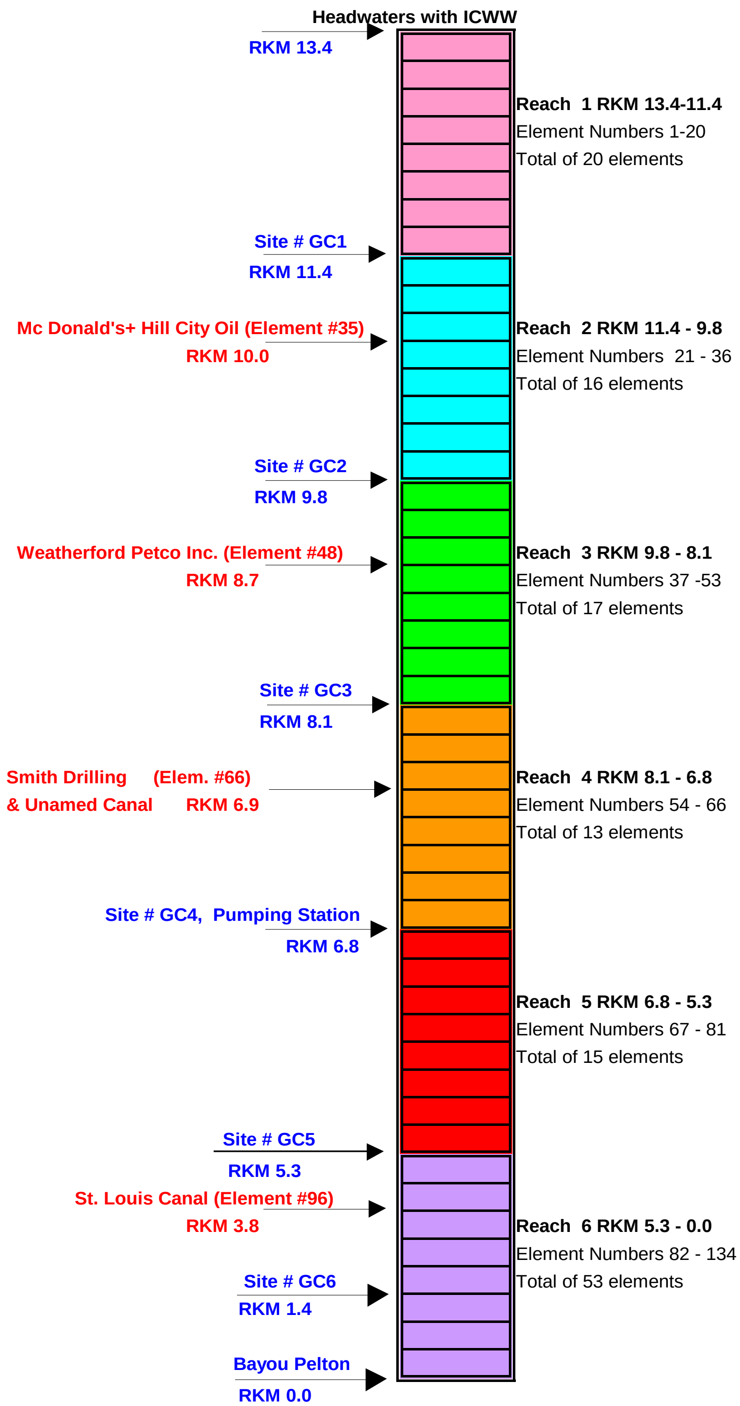
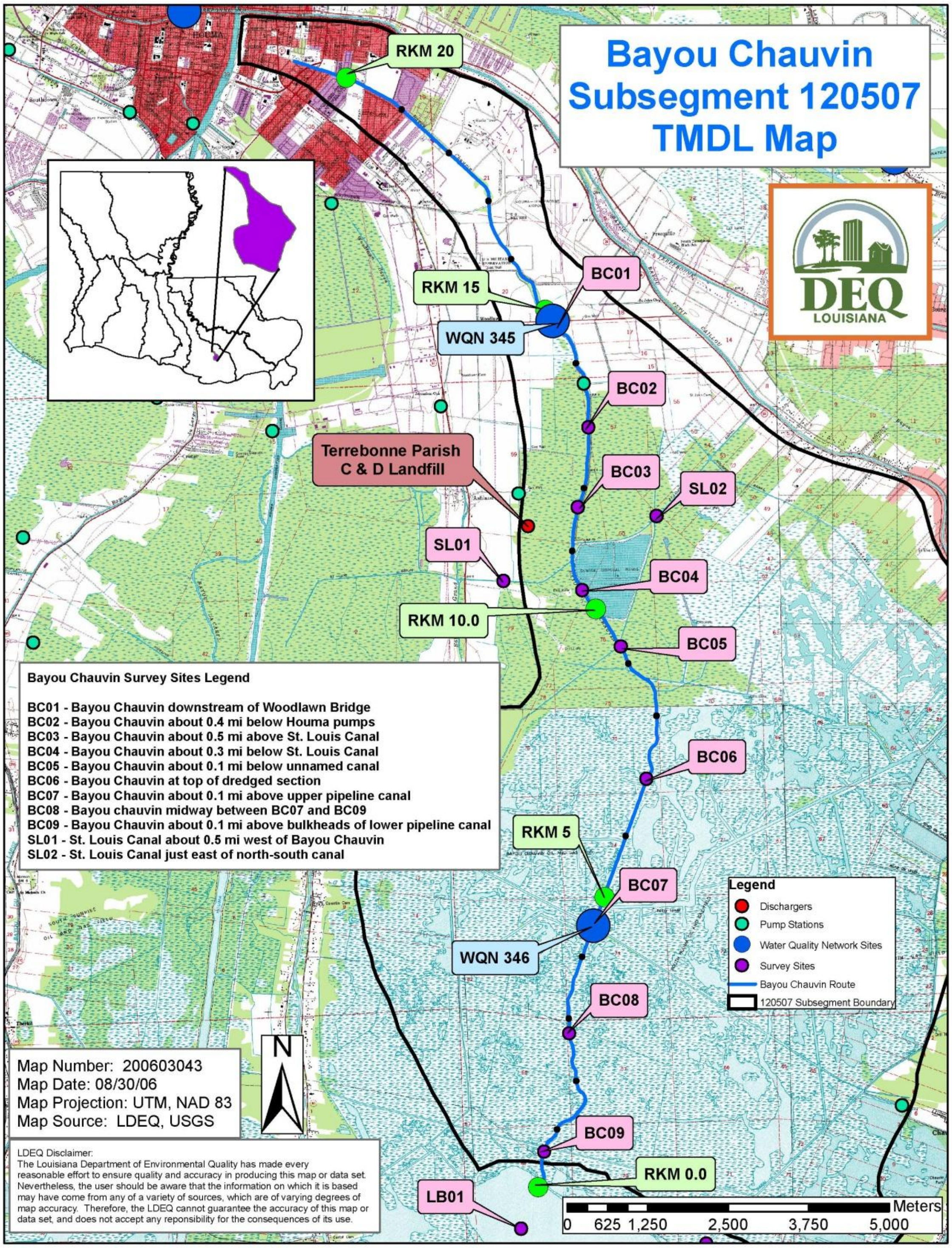
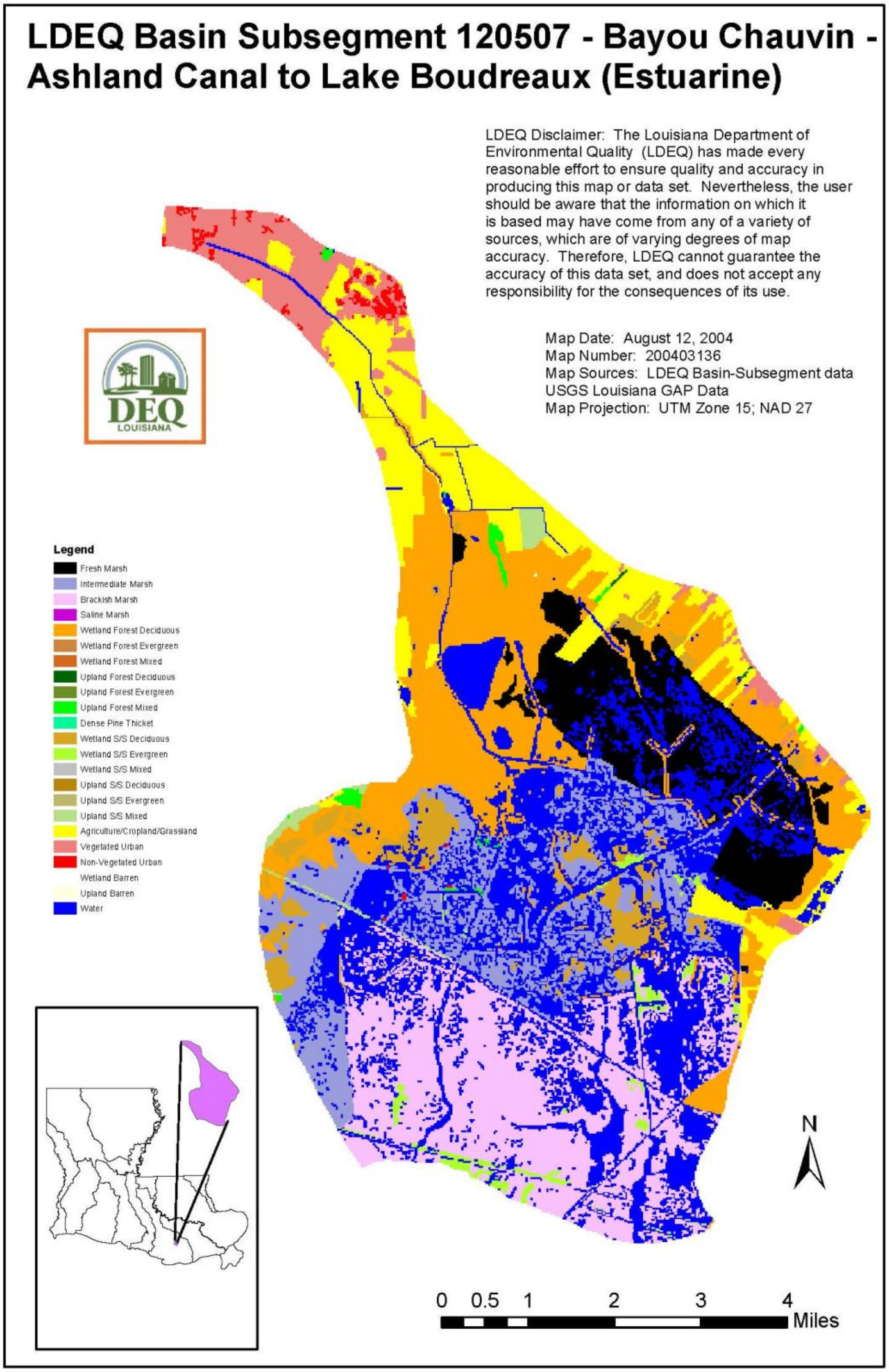
APPENDIX

Bayou Grand Caillou Model Layout



Vector Diagram


Bayou Chauvin
Subsegment 120507
TMDL Map
LOUISIANA
RKM 20
RKM 15
BC01
WQN 345
BC02
Terrebonne Parish
C & D Landfill
BC03
SL02
SL01
BC04
RKM 10.0
BC05
Bayou Chauvin Survey Sites Legend
BC01 - Bayou Chauvin downstream of Woodlawn Bridge
BC02 - Bayou Chauvin about 0.4 mi below Houma pumps
BC03 - Bayou Chauvin about 0.5 mi above St. Louis Canal
BC04 - Bayou Chauvin about 0.3 mi below St. Louis Canal
BC05 - Bayou Chauvin about 0.1 mi below unnamed canal
BC06 - Bayou Chauvin at top of dredged section
BC07 - Bayou Chauvin about 0.1 mi above upper pipeline canal
BC08 - Bayou chauvin midway between BC07 and BC09
BC09 - Bayou Chauvin about 0.1 mi above bulkheads of lower pipeline canal
SL01 - St. Louis Canal about 0.5 mi west of Bayou Chauvin
SL02 - St. Louis Canal just east of north-south canal
BC06
RKM 5
BC07
WQN 346
BC08
Legend
Dischargers
Pump Stations
Water Quality Network Sites
Survey Sites
Bayou Chauvin Route
120507 Subsegment Boundary
N
Map Number: 200603043
Map Date: 08/30/06
Map Projection: UTM, NAD 83
Map Source: LDEQ, USGS
BC09
RKM 0.0
LB01
LDEQ Disclaimer:
The Louisiana Department of Environmental Quality has made every reasonable effort to ensure quality and accuracy in producing this map or data set. Nevertheless, the user should be aware that the information on which it is based may have come from any of a variety of sources, which are of varying degrees of map accuracy. Therefore, the LDEQ cannot guarantee the accuracy of this map or data set, and does not accept any reponsibility for the consequences of its use.
Meters
0 625 1,250 2,500 3,750 5,000


LDEQ Basin Subsegment 120507 - Bayou Chauvin - Ashland Canal to Lake Boudreaux (Estuarine)
LDEQ Disclaimer: The Louisiana Department of Environmental Quality (LDEQ) has made every reasonable effort to ensure quality and accuracy in producing this map or data set. Nevertheless, the user should be aware that the information on which it is based may have come from any of a variety of sources, which are of varying degrees of map accuracy. Therefore, LDEQ cannot guarantee the accuracy of this data set, and does not accept any responsibility for the consequences of its use.
Map Date: August 12, 2004
Map Number: 200403136
Map Sources: LDEQ Basin-Subsegment data
USGS Louisiana GAP Data
Map Projection: UTM Zone 15; NAD 27
DEQ
LOUISIANA
Legend
Fresh Marsh
Intermediate Marsh
Brackish Marsh
Saline Marsh
Wetland Forest Deciduous
Wetland Forest Evergreen
Wetland Forest Mixed
Upland Forest Deciduous
Upland Forest Evergreen
Upland Forest Mixed
Dense Pine Thicket
Wetland S/S Deciduous
Wetland S/S Evergreen
Wetland S/S Mixed
Upland S/S Deciduous
Upland S/S Evergreen
Upland S/S Mixed
Agriculture/Cropland/Grassland
Vegetated Urban
Non-Vegetated Urban
Wetland Barren
Upland Barren
Water
N
0 0.5 1 2 3 4
Miles

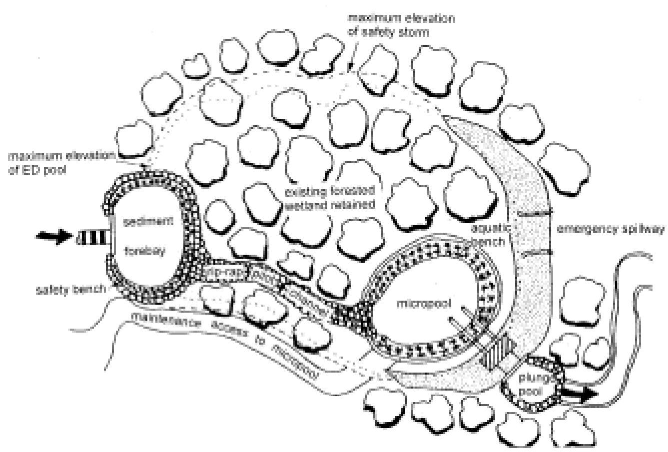
EXTENDED DETENTION PONDS *BMP Fact Sheet #1*

Definition

Conventional Extended Detention (ED) Ponds temporarily detain a portion of storm water runoff for up to twenty-four hours after a storm using a fixed orifice. Such extended detention allows urban pollutants to settle out. The ED ponds are normally dry between storm events and do not have any permanent standing water.

Enhanced ED Ponds are designed to prevent clogging and resuspension. They provide greater flexibility in achieving target detention times. Along with a detention area, they include a sediment forebay near the inlet, a micropool and/or plunge pool at the outlet, and utilize an adjustable reverse-sloped pipe as the ED control device to prevent resuspension of particles deposited in earlier storms.

Schematic Design of an Enhanced Dry ED Pond System



Source: Schueler, 1991.

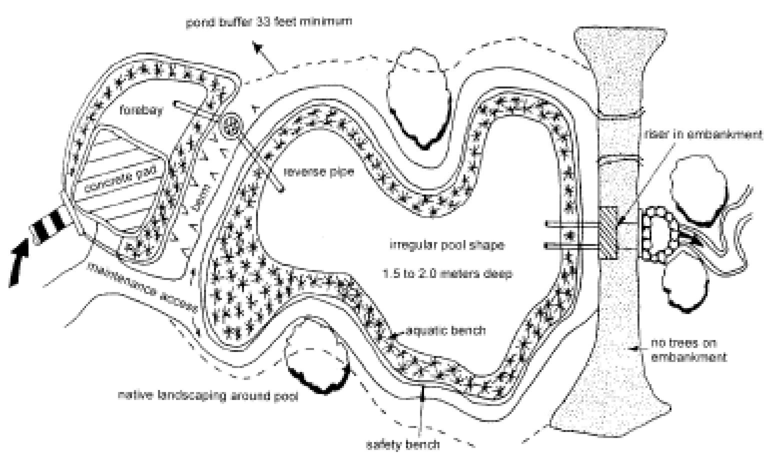
WET PONDS — *BMP Fact Sheet #2*

Definition

Conventional Wet Ponds have a permanent water pool to treat incoming storm water runoff.

In **Enhanced Wet Pond** designs, a forebay is installed to trap incoming sediments where they can be easily removed; a fringe wetland is also established around the perimeter of the pond.

Schematic Design of an Enhanced Wet Pond System



Source: Schueler, 1991.

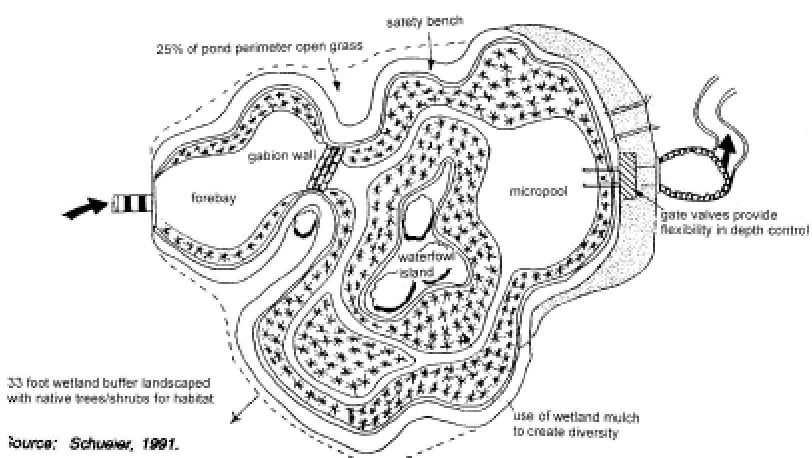
STORM WATER WETLANDS *BMP Fact Sheet #3*

Definition

Conventional Storm Water Wetlands are shallow pools that create growing conditions suitable for the growth of marsh plants. These storm water wetlands are designed to maximize pollutant removal through wetland uptake, retention and settling. **Storm water wetlands** are constructed systems and typically are not located within delineated natural **wetlands.** In addition, storm water wetlands differ from other artificial wetlands created to comply with mitigation requirements in that they do not replicate all the ecological functions of natural wetlands. Functional differences will depend on the design of the storm water wetland, interactions with groundwater and surface water, and local storm climate.

Enhanced Storm Water Wetlands are designed for more effective pollutant removal and species diversity. They also include design elements such as a forebay, complex microtopography, and pondscaping with multiple species of wetland trees, shrubs and plants.

Schematic Design of an Enhanced Shallow Marsh System



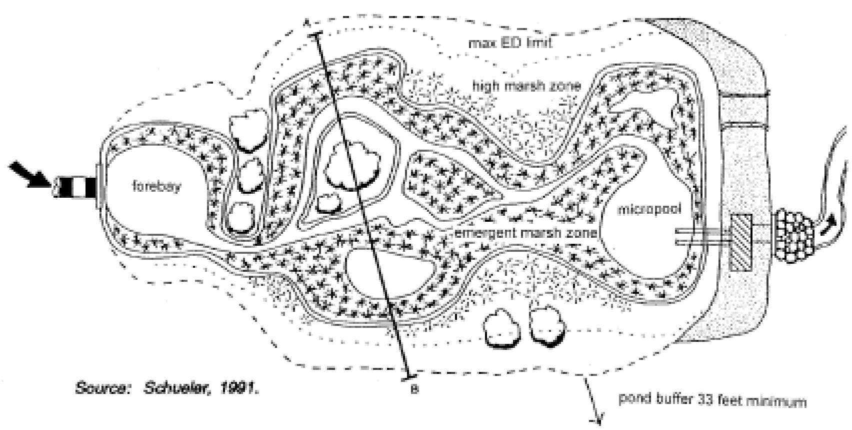
Source: Schueler, 1991.

MULTIPLE POND SYSTEMS — *BMP Fact Sheet #4*

Definition

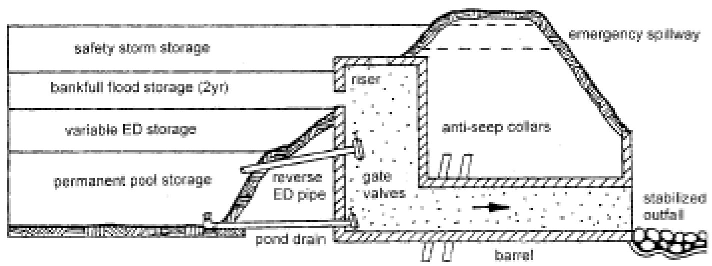
Multiple Pond Systems is a collective term for a cluster of pond designs that incorporate redundant runoff treatment techniques within a single pond or series of ponds. These Pond designs employ a combination of two or more of the following: extended detention, permanent pool, shallow wetlands, or infiltration in a "treatment train." Examples of a multiple pond system include the wet ED pond, ED wetlands, infiltration basins and pond-marsh systems.

Schematic Design of a Shallow ED Marsh System



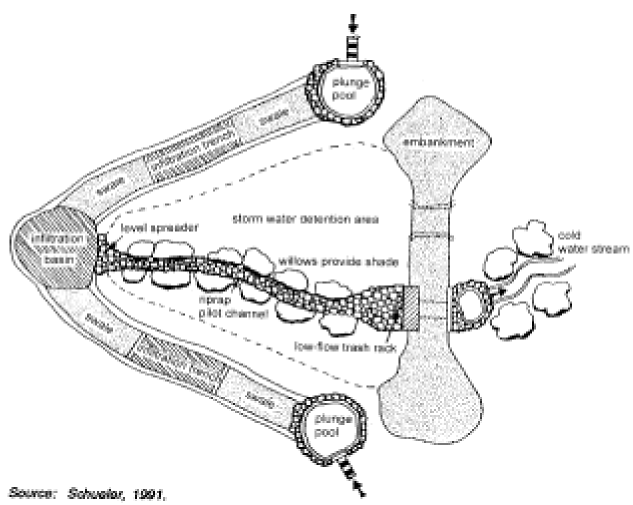
Source: Schueler, 1991.

Cross-section View of a Standard ED Pond System Design



Source: Schueler, 1991.

Schematic Design of a Dry In-filter System



Source: Schueler, 1991.

INFILTRATION TRENCHES *BMP Fact Sheet #5*

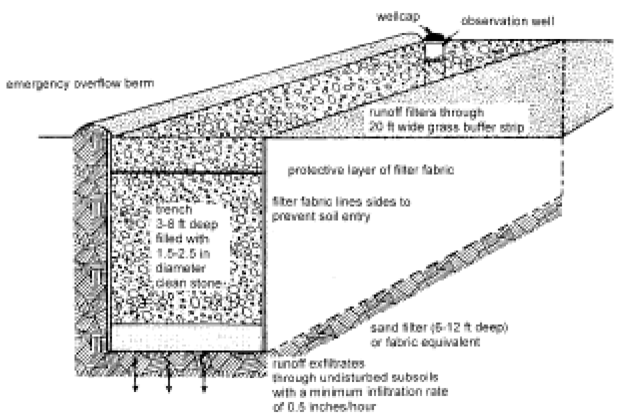
Definition

a Conventional Infiltration Trench is a shallow, excavated trench that has been backfilled with stone to create an underground reservoir. Storm water runoff diverted into the trench gradually exfiltrates from the bottom of the trench into the subsoil and eventually into the water table. Trenches may be designed to accept the "first flush" volume (½ runoff per acre of impervious surface) or for larger volumes of runoff. A design variation is a dry well to control small volumes of runoff, such as roof top runoff.

Enhanced Infiltration Trenches have extensive pretreatment systems to remove sediment and oil.

Both types of trenches require on-site geotechnical investigations to determine appropriate design and location.

Schematic Design of a Conventional Infiltration Trench



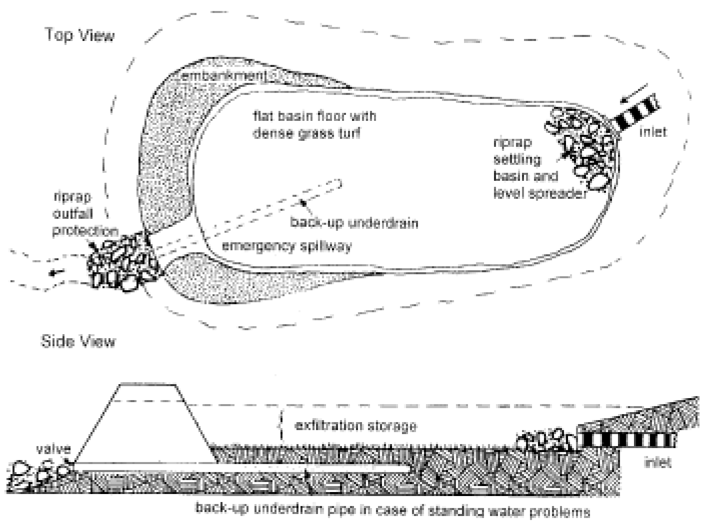
Source: Schueler, 1987.

INFILTRATION BASINS *BMP Fact Sheet #6*

Definition

Infiltration basins are impoundments where incoming storm water runoff is stored until it gradually exfiltrates through the soil of the basin floor.

Schematic Design of an Infiltration Basin



Source: Schueler, 1987.

Pollutant Removal Capability:

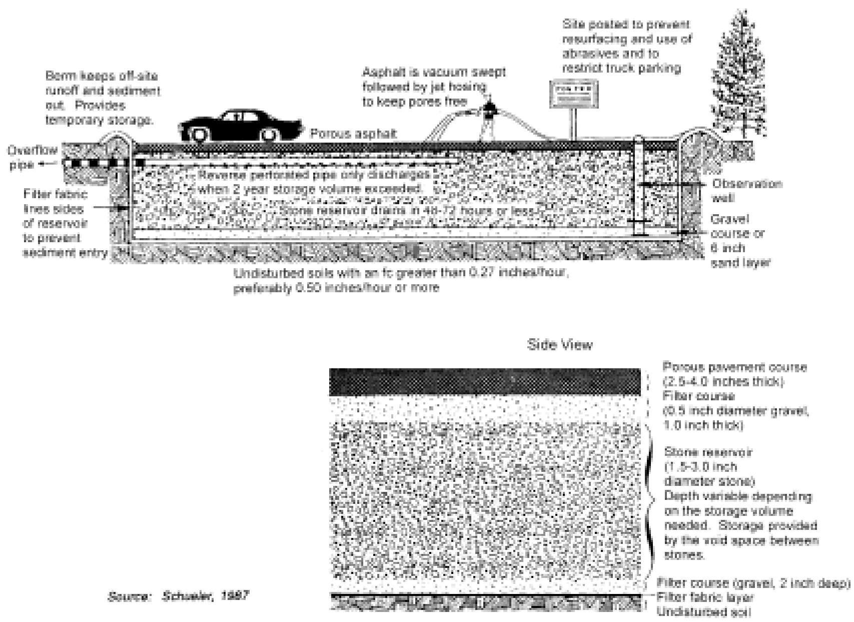
No performance data on infiltration basins is available; however, they are presumed to have the same general removal efficiencies reported for infiltration trenches: high removal for particulate pollutants and moderate removal for soluble pollutants.

POROUS PAVEMENT — *BMP Fact Sheet #7*

Definition

Porous Pavement is an alternative to conventional pavement whereby runoff is diverted through a porous asphalt layer and into an underground stone reservoir. The stored runoff then gradually infiltrates into the subsoil.

Schematic Design of a Porous Pavement System



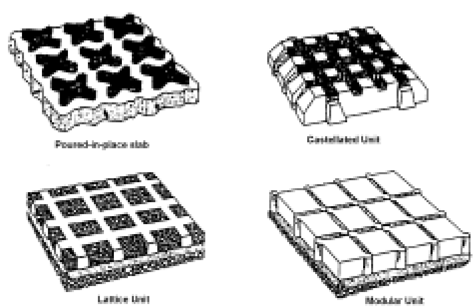
Source: Schueler, 1987

CONCRETE GRID PAVEMENT *BMP Fact Sheet #8*

Definition

Concrete Grid Pavement is an alternative to conventional and porous pavement which acts like an infiltration system. Storm water percolates through voids in the concrete into the soils. Concrete is typically placed on a sand or gravel base, regularly inter-dispersed with void areas filled with pervious materials such as sand, gravel or grass. There are several concrete grid systems including concrete poured in place, precast concrete grids or modular pavers (Livingston, et. al., 1997). Plastic modular blocks are also available (Debo and Reese, 1995).

Schematic Design of a Concrete Grid Pavement System



Source: Watershed Management Institute, Inc. 1997

Pollutant Removal Capability:

Include adsorption, straining, and microbial decomposition in the sub-soil below the base material, and trapping of particulate matter within the base material. The annual rain fall volume is diverted to groundwater rather than surface runoff .

SAND FILTERS

BMP Fact Sheet #9

Definition

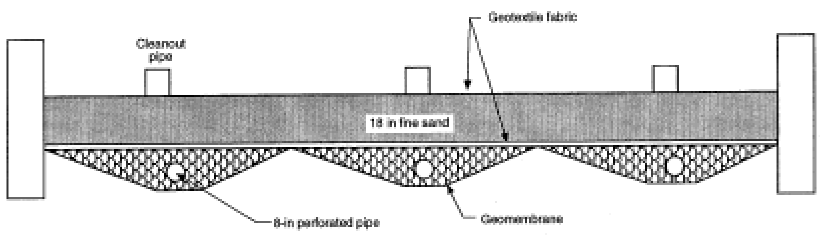
Sand filters are a relatively new technique for treating storm water, whereby the first flush of runoff is diverted into a self-contained bed of sand. The runoff is then strained through the sand, collected in underground pipes and returned back to the stream or channel. Storage is generally calculated on the runoff volume of 0.5 inches of rainfall per impervious acre (Debo and Reese, 1995).

Sand filters may be an "unconfined," sand-filled trench with a perforated underdrain. There are also "confined" systems where the filter medium is contained in a concrete vault with a drain at the bottom of the vault. Depending on the specific design, these types of filters are often referred to as "Delaware Filters" or "Austin Filters" after the localities where they were initially designed or installed. Large sand filters are installed above ground and are self-contained sand beds that can treat storm water from drainage areas as much as five acres in size (NCSU, 1998).

Enhanced Sand Filters utilize layers of peat, limestone, leaf compost and/or topsoil, and may also have a grass cover crop. The adsorptive media of enhanced sand filters is expected to improve removal rates.

In addition, **sand-trench** systems have been developed to treat parking lot runoff.

Schematic Design of a Sand Filter System



Source: Austin, Texas 1991.

GRASSED SWALES *BMP Fact Sheet #10*

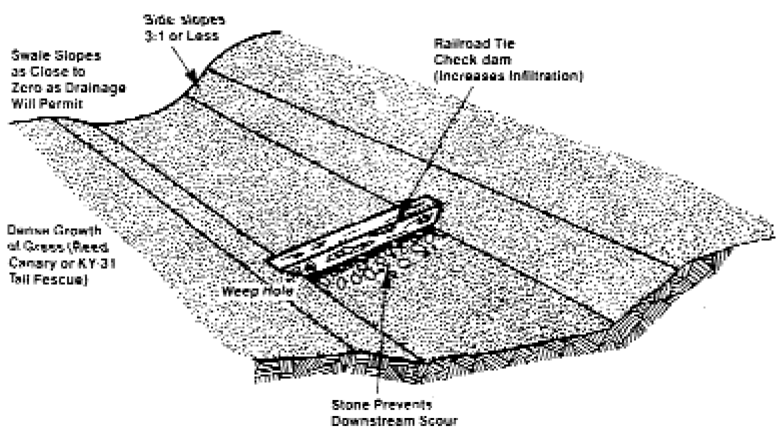
Definition

Conventional Grassed Swales are earthen conveyance systems in which, pollutants are removed from urban storm water by filtration through grass and infiltration through soil. Swales should be designed with relatively wide bottoms to promote even flow through the vegetation and avoid channelization, erosion, or high velocities.

In areas where grass is not easy to grow or maintain, rip rap lined channels may be considered an option (DRCOG, 1998).

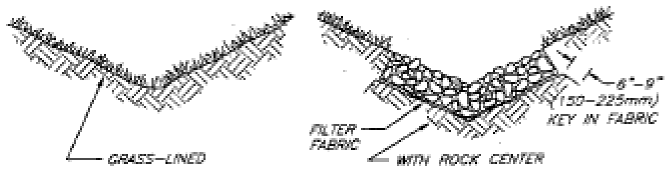
Enhanced Grassed Swales, or **Biofilters,** utilize check dams and wide depressions to increase runoff storage and promote greater settling of pollutants.

Schematic Design of an Enhanced Grassed Swale



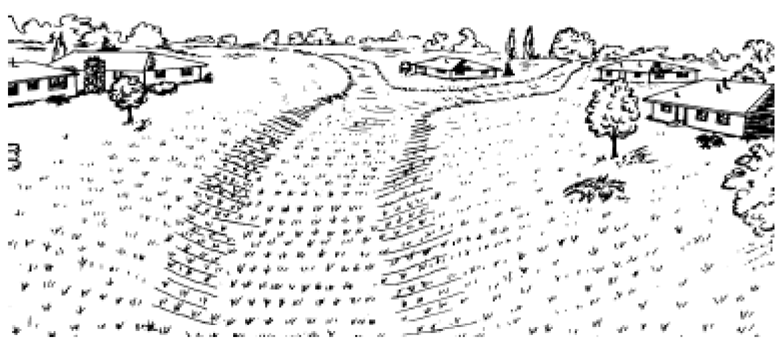
Source: *Schueler, 1987.*

Schematic Cross-section of Grassed Swales: without and with rock bottom



Source: Denver Regional Council of Governments, 1998

Schematic of Urban Swale:



Source: USDA, 1978

FILTER STRIPS *BMP Fact Sheet #11*

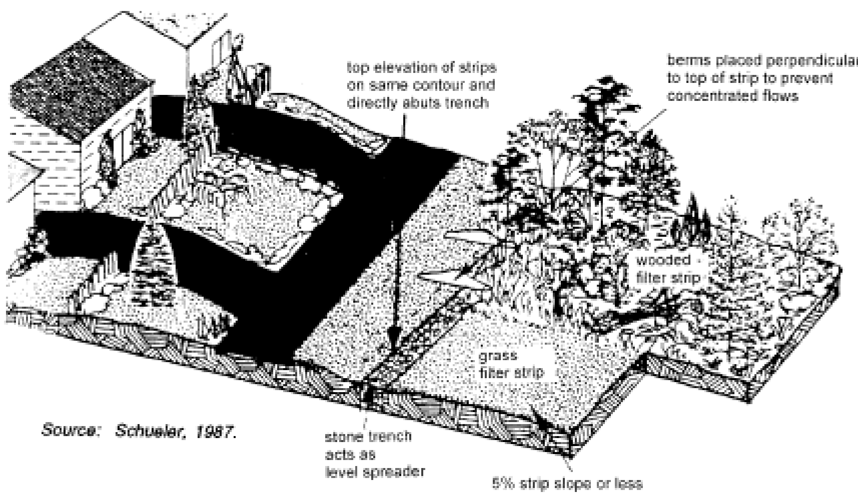
Definition

Filter Strips are vegetated sections of land designed to accept runoff as overland sheet flow from upstream development. They may adopt any natural vegetated form, from grassy meadow to small forest. The dense vegetative cover facilitates pollutant removal. **Filter strips** cannot treat high velocity flows; therefore, they have generally been recommended for use in agriculture and low density development.

Filter strips differ from **natural buffers** in that strips are not "natural;" rather, they are designed and constructed specifically for the purpose of pollutant removal. A filter strip can also be an **enhanced natural buffer,** however, whereby the removal capability of the natural buffer is improved through engineering and maintenance activities such as land grading or the installation of a level spreader.

Filter strips also differ from **grassed swales** in that swales are concave, vegetated conveyance systems, whereas **filter strips** have fairly level surfaces.

Schematic Design of a Filter Strip



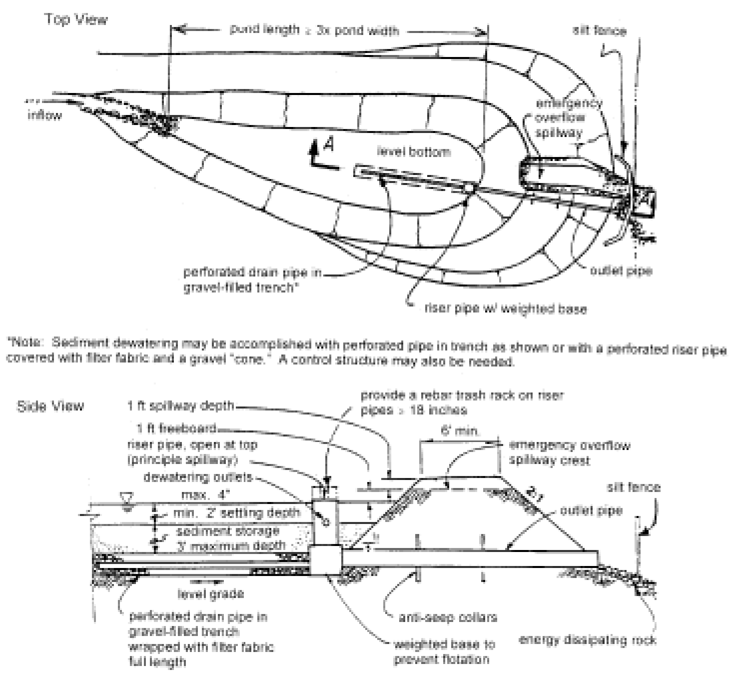
Source: Schueler, 1987.

SEDIMENT TRAPS — *BMP Fact Sheet #12*

Definition

Sediment Traps are small impoundments that allow sediment to settle out of runoff water. Sediment traps are typically installed in a drainage way or other point of discharge from a disturbed area (Horner, et. al., 1994).

Schematic Design of a Sediment Trap



Source: Washington Dep. Ecol. 1992.

WIND EROSION CONTROLS *BMP Fact Sheet #13*

Definition:

Wind Erosion Controls limit the movement of dust from disturbed surfaces and may include many different practices. Different materials such as wood fence, snow fence, vegetation (trees and shrubs) and straw bales may be used as barriers. Sprinkling areas with water may also be used.

Pollutant Removal Capability:

Wind erosion control practices are designed to prevent airborne sedimentation. Vegetative windbreaks also serve a soil stabilization function.

Feasibility:

Feasibility: Wind erosion control practices can be applied to construction sites and other areas where loss of vegetation has occurred.

Adaptability: Can be adapted in all areas where high winds are an environmental condition. In arid climates, vegetative controls may require irrigation.

Development Feasibility: Useful in areas where natural or manmade (buildings, wood fences) windbreaks do not exist.

Use in Ultra-urban Areas: Not useful in developed areas.

Retrofit Capability: May be developed in existing open space areas.

Storm Water Management Capability: Does not directly influence storm water runoff, although wind erosion can be a cause of sedimentation in runoff.

Maintenance:

Trees and Shrubs: Weeding in the first years after installation will enhance tree survival. Periodic pruning is necessary to long term performance and appearance. Dead, damaged or diseased trees should be replaced.

Other structures: Require periodic maintenance to replace damaged areas.

Longevity: Dependant upon maintenance.

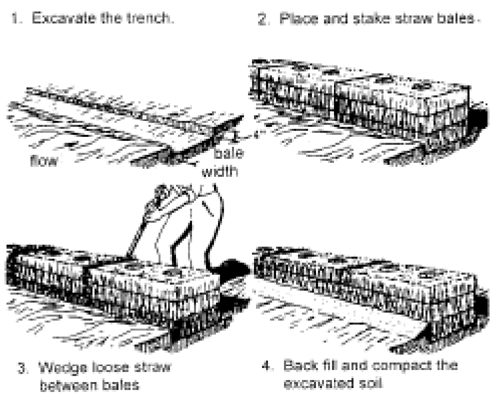
CHECK DAMS-SILT FENCE *BMP Fact Sheet #14*

Definition

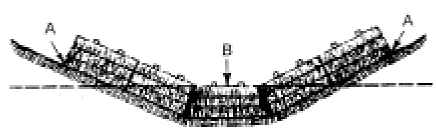
Check Dams are small, temporary dams constructed across a swale or channel. They are generally constructed of hay or straw bales gravel or rock.

Silt Fence is designed to slow runoff so sediment settles. It is available in several mesh sizes. Silt fence may also be referred to as filter fence.

Schematic Design for a Hay/Straw Dam



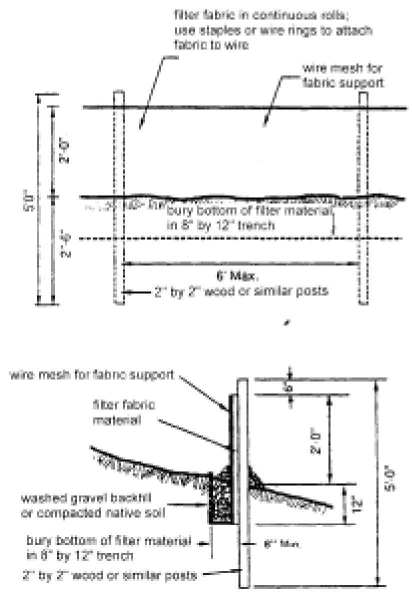
Construction of a Straw Bale Barrier



Proper Placement of Straw Bale Barrier in Drainage Way

Source: Washington Dep. Ecol. 1992.

Schematic Design for a Silt Fence



Source: Washington Dep. Ecol. 1992.

Pollutant Removal Capability:

Effective against large particle sediment, primarily sands and larger silts if installed correctly.

Pollutant Removal Mechanisms: Sediment settling through pooling of water to slow velocity.

Factors Influencing Pollutant Removal:

Positive Factors

- Temporary control measure
- Large particle removal
- Proper installation to reduce piping

Negative Factors

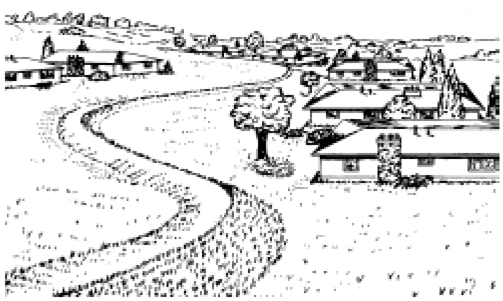
- Concentrated or high velocity flows
- Hay is attractive to livestock and wildlife which will shorten check dam life
- Silt fence may be knocked down by livestock or wildlife

STEEP SLOPE DIVERSION TERRACES BMP Fact Sheet #15

Definition

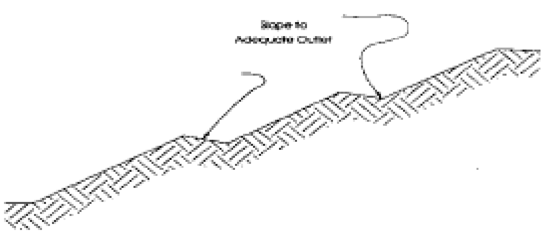
Steep Slope Diversion Terraces break up a slope by providing areas of low slope in the reverse direction, keeping water from proceeding down slope at increasing volume and velocity. Terraces generally direct flow across a vegetated, steep slope to a stable outlet (Dodson, 1995).

Schematic Design for Steep Slope Terraces



Source: USDA, 1978

Schematic Cross-Section Steep Slope Terraces



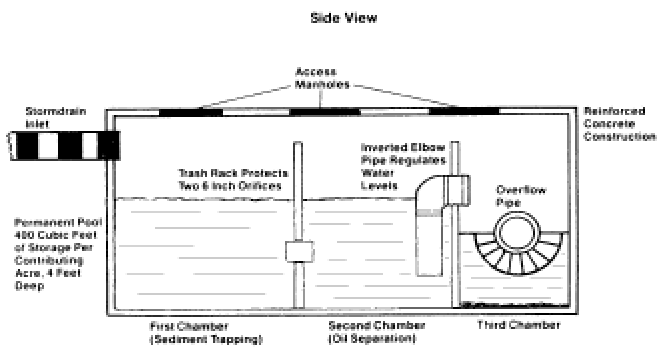
Source: EPA, 1992

WATER QUALITY INLETS/ OIL-WATER SEPARATORS ***BMP Fact Sheet #16***

Definition

A **Water Quality Inlet** is a three-stage underground retention system designed to remove heavy particulates and small amounts of petroleum products from storm water runoff. Also known as an **Oil/grit Separator** or an **Oil-water Separator**. As water flows through the three chambers, oils and grease separate either to the surface or to sediments and are skimmed off and held in the catch basin or storage tank. The storm water then passes on to the sanitary sewer, storm sewer or into another storm water pollution control device (NCSU, 1998).

Schematic Design for Water Quality Inlet Oil Grit Separator



Source: Schueler, 1987.

Pollutant Removal Capability:

Current designs of water quality inlets trap coarse-grained sediments and small amounts of oil. Removal of silt, clay, nutrients, trace metals, soluble pollutants and organic matter is expected to be slight. Pollutant removal also depends on the basin volume, flow velocity, and the depth of baffles and elbows in the chamber design (NCSU, 1998). Water quality inlets may function best as a first stage in the treatment of storm water.

STREAMBANK STABILIZATION *BMP Fact Sheet #17*

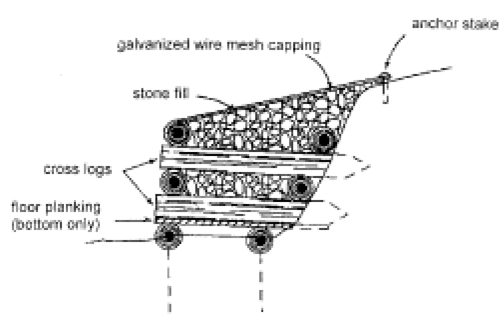
Definition:

Streambank Stabilization controls erosion through management of water velocity and/or stream bank stability by natural and manmade controls to decrease bank erosion and sediment loading in waterways. Structural or vegetative means may be used separately or together.

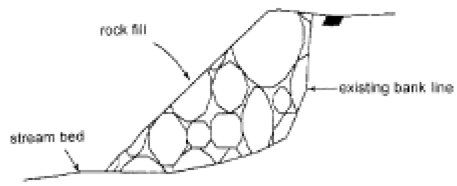
Structural Streambank Stabilization decreases erosion by deflecting water energy away from the streambank. Methods include gabion baskets, rip rap, slope paving, log cribbing as well as in-channel diversion structures (Dodson, 1995).

Vegetative Streambank Stabilization, also known as **Bioengineering** or **Soil Bioengineering**, describes several methods of establishing vegetative cover by embedding a combination of live, dormant and/or decaying plant materials into banks and shorelines (TBG, Inc., 1998).

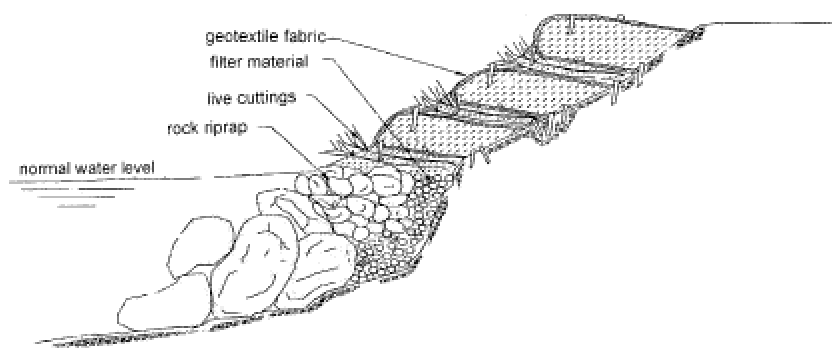
Schematic Designs for Streambank Stabilization Controls



Log Cribbing
Source: Dodson, 1995



Rock Rip Rap
Source: EPA, 1992



Bioengineering
Source: USDA, 1994

MISCELLANEOUS BMPs FOR URBAN CONSTRUCTION — *BMP Fact Sheet #18*

Problem

Urban construction results in areas of exposed soils, often in proximity to storm drains, streams or other water bodies. The following BMPs may be used singly or with others to reduce erosion and sedimentation.

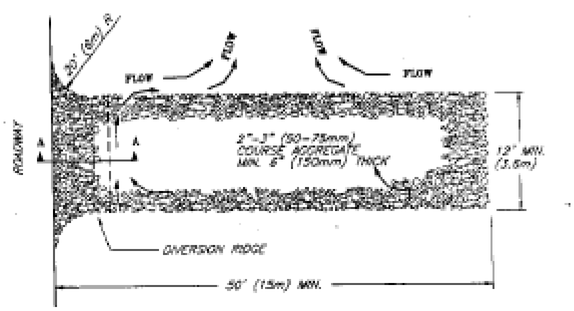
Vehicle Tracking Controls

Vehicle tracking controls stabilize construction entrances. The controls typically consist of an asphalt or rock bed at least 50 feet long separating construction areas from public roads. The asphalt or rock bed provides an area that removes loose sediment from tires of vehicles.

The asphalt or rock bed must be maintained to be effective. Maintenance includes:

- clean paved surfaces by shoveling or sweeping
- add rock to tracking pad as needed

Schematic for vehicle tracking controls



Source: Denver Regional Council of Governments, 1998

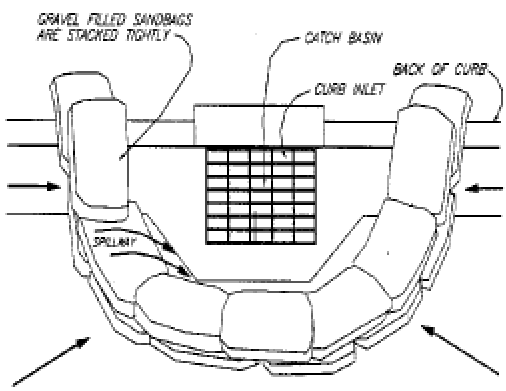
Inlet Protection

Inlet protection consists of sediment filters around storm drain drop inlets or curb inlets. Construction activities may result in significant amounts of sediments entering storm drainage system. Inlet protection should remain in place until the potential for erosion is minimal.

Gravel-filled sand bags may be packed tightly around curb inlets or drop inlets to filter sediment from storm water before it enters a storm drain system. Straw bales or filter fabric may also be used if the situation is such that they can be trenched in.

Inlet protection should not pond water so as to interfere with construction or damage adjacent property.

Schematic for Inlet Protection

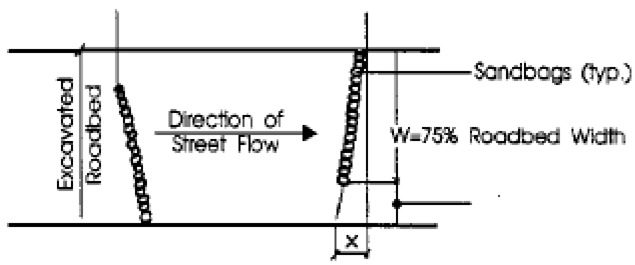


Source: Denver Regional Council of Governments, 1998

Rough-cut Street Controls

Rough-cut street controls are dirt berms or sandbag dikes used to prevent rill, channel and gully erosion on unpaved surfaces. Controls are particularly essential on streets cut onto sloping surfaces. Controls work by routing sheet flows off unpaved and unstabilized surfaces to stabilized swales along the sides of roads, other vegetated areas, or detention ponds. Controls should be installed at regular intervals along the road (especially sloping roads) and the steeper the slope, the closer the diversions should be placed. The longer a path storm water has along an unstabilized, sloping surface, the more potential there is for erosion and sediment transport off-site.

Schematic for Rough-cut street controls



Source: Denver Regional Council of Governments, 1998

Erosion Control Blankets

Erosion control blankets are used in place of mulch on areas of high velocity runoff and/or steep grade to control erosion on critical areas by protecting young vegetation.

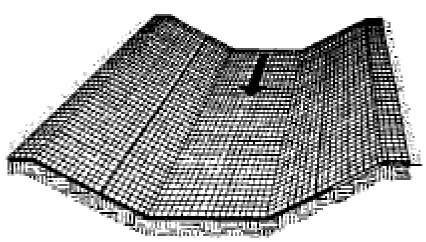
Erosion control blankets are most useful where:

- Vegetation is likely to grow too slowly to provide adequate cover
- High winds render mulch an ineffective control

As with bale check dams and silt fences, proper installation of erosion control blankets is essential for maximum erosion control.

- Erosion control blankets should be installed parallel to the direction of flow
- Blanket ends should be buried at least six inches deep
- Erosion control blankets should be placed loosely on the soil - not stretched
- Edges should be stapled at least every three feet.

Schematic for Erosion Control Blanket Installation



Source: Denver Regional Council of Governments, 1998

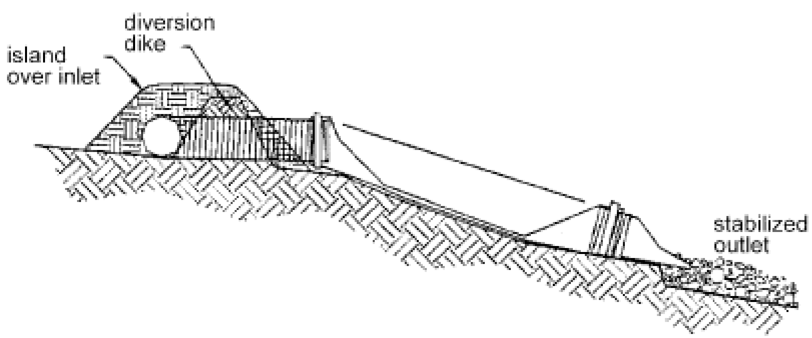
Temporary Slope Drains

Temporary slope drains are flexible or rigid conduits that extend from the top to the bottom of a cut or fill slope. Storm water is routed down the slope through the pipe to a stabilized outlet, avoiding erosion of a bare slope.

Slope drains may be permanent or temporary. Permanent slope drains are often buried, while temporary slope drains usually sit on top of the slope.

Careful installation is important; failed slope drains often result in gully erosion on the slope and sedimentation at the slope base.

Schematic for a Slope Drain



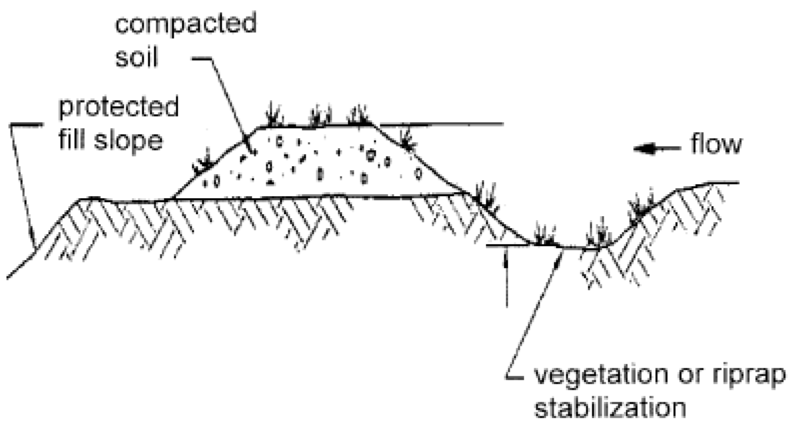
Source: Denver Regional Council of Governments, 1998

Temporary Diversion Dike

Temporary diversion dikes are, traditionally, ridges of compacted soil constructed at the top or base of a sloping disturbed area. Diversion dikes work by diverting runoff from unprotected areas or diverting sediment-laden runoff into a sediment-trapping facility.

- Vegetating the dike will further reduce sedimentation
- The gradient of the channel behind the dike should be low enough to prevent erosion, but steep enough to provide drainage
- The channel outlet should be stabilized with vegetation or rip rap.

Schematic for a Temporary Diversion Dike



Source: Denver Regional Council of Governments, 1998

Mulching and Surface Roughening

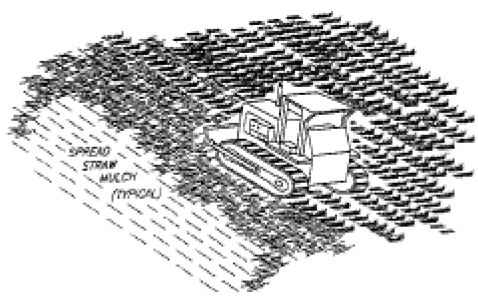
Management Options

- Rapid establishment of mulch or mulch combined with seeding can reduce runoff in cleared and graded areas by up to sixfold. Temporary stabilization within 7-14 days is recommended.
- Mulching is conducive to stabilizing sloped areas. Several materials are appropriate. The useful life is two to six months depending upon the material used. On steep slopes or in highly erodible soils, multiple treatments may be appropriate.
- Surface roughening involves creating grooves perpendicular to a slope. Roughening may be effective where mulching is not due to high winds or steep slopes (DRCOG, 1998). Roughening may also be the BMP of choice when activities will occur in the area within a few days.

Maintenance:

- Mulched or roughened areas should be inspected frequently, especially after rain or wind.
- Reapply mulch or surface roughening as necessary (DRCOG, 1998)

Schematics for Mulching and Surface Roughening



Source: Denver Regional Council of Governments, 1998